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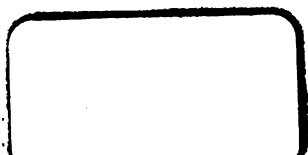
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Emily Dineen



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1. The first part of the document is a list of names and titles, including "The Hon. Mr. Justice" and "The Hon. Mr. Justice".

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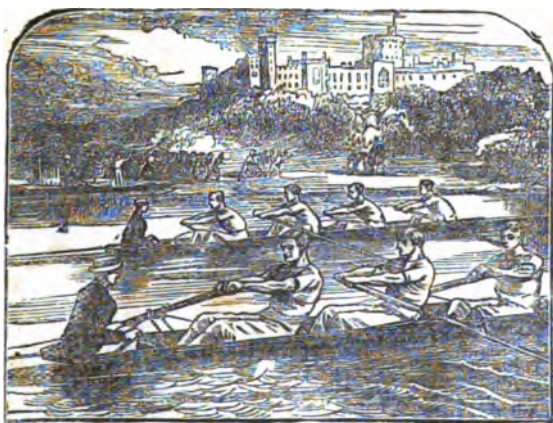
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## COMPLETE ENCYCLOPEDIA



ATHLETIC, SCIENTIFIC, OUTDOOR AND INDOOR SPORTS.

WITH ILLUSTRATIONS.



NEW YORK:

**JAMES MILLER, PUBLISHER,**

779 BROADWAY.

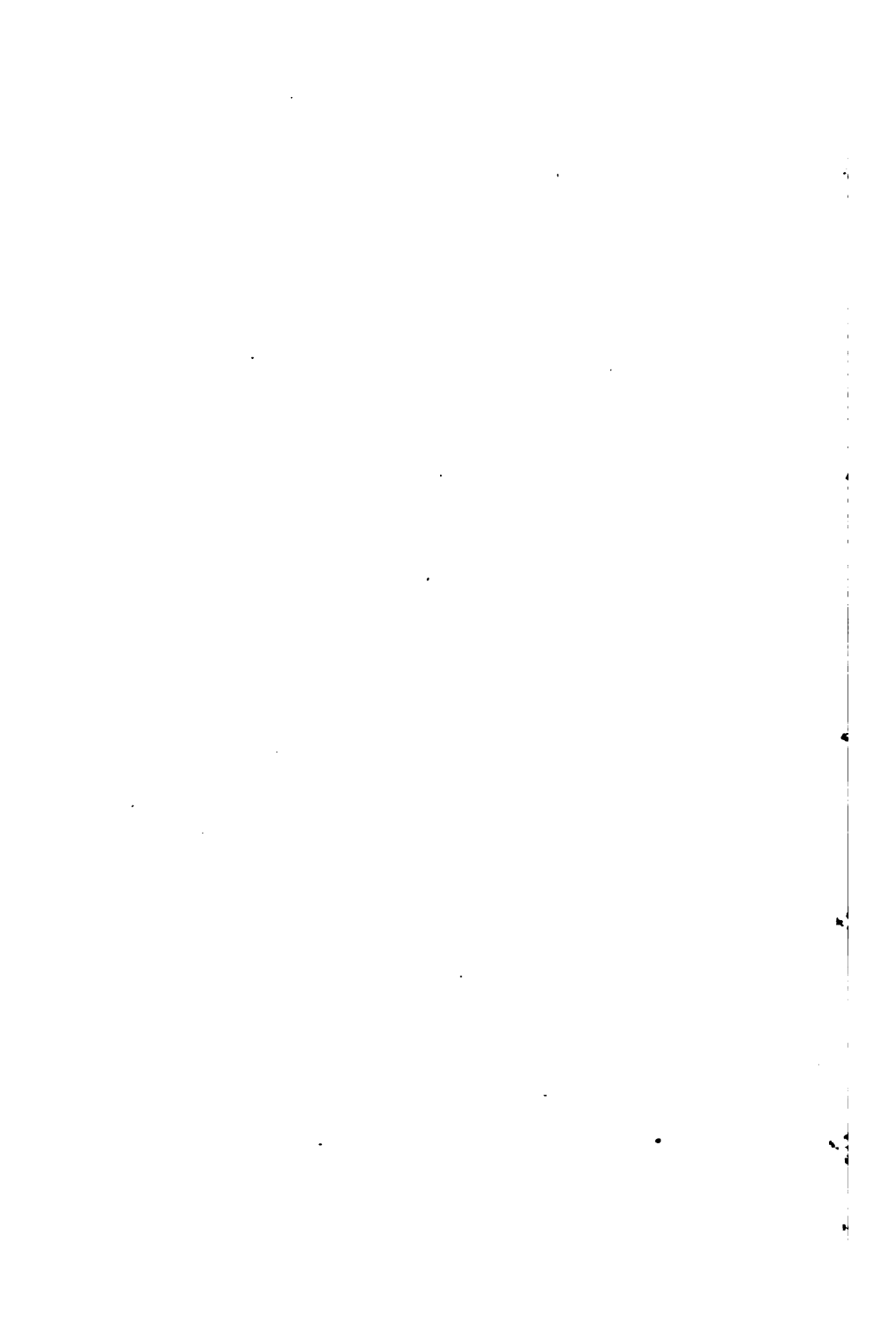
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As it is impossible for a single person to write a book of this description with a fair prospect of success, treating of all the different games that come under this heading, I would state that I am largely indebted to the following works for many parts that I am not intimately acquainted with, viz.: "The American Boy's Book," "Every Boy's Book;" and "The Modern Playmate." Many of the games have been so revised as hardly to be remembered as the same game the editor played when a boy. For example, the simple and almost abandoned game of "Rounders," or "Town Ball," has risen to a science under the name of "Base Ball," while such as "Croquet," "Football," "Cricket," and "La Crosse," are given as they now exist after many years of practice have reduced their varied rules to a common standard.



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## BOYS' OWN BOOK.

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### *FOOTBALL.*

A match is made between two sets of players of equal numbers ; a large ball made of light materials—a blown bladder, cased with leather, is the best—is placed between them, and the object of each party is to kick the ball across the goal of the other, and to prevent it from passing their own. The party, across whose goal the ball is kicked, loses the game. The game is commenced between the two goals, which are about a hundred yards asunder.

In the game of Football the fewer the rules, and the simpler those rules are, the better. The great contention now is whether the players shall be allowed to touch the ball with their hands or not. The code of rules given below is the

result of many years' paring and revision, under the test of constant hard play.

A few hours' play will be sufficient to give an insight into the practical working of these rules.

*Theory of the Game.*—Football, like cricket, requires two opposing sides. It is played with a hollow ball, eight or ten inches in diameter. It is a game only suitable for cold weather, as base-ball is for hot.

#### RULES.

1. The length of the ground shall be not more than 150 yards, and the breadth 55 yards. The ground shall be marked out by posts, two at each end, parallel with the goal-posts, and 55 yards apart; and by one at each side of the ground, half-way between the side-posts.

2. The goal shall consist of two uprights 15 feet apart, with a cross-bar 8 feet from the ground.

3. The choice of goal and kick-off shall be determined by tossing.

4. In a match, when half the time agreed upon has elapsed, the sides shall change goals the next time the ball is out of play. In ordinary games the change shall be made after every goal.

5. The heads of sides shall have the sole management of the game.

6. The ball shall be put in play as follows :

(a) At the commencement of the game, and after every goal, by a place-kick 25 yards in advance of the goal, by either side alternately, each party being arrayed on its own ground.

(b) If the ball has been played behind the goal-line (1) by the opposite party, the side owning the goal shall have a place-kick from behind the goal-line at their discretion; (2) by the side owning the goal, whether by kicking or guiding, the opposite party shall have a place-kick from a spot 25 yards in front of the goal at their discretion.

(c) If the ball has been played across the side-lines, the player first touching it with the *hand* shall have a place-kick from the point at which the ball crossed the line.

7. In all the above cases, the side starting the ball shall be *out of play* until one of the opposite side has played it.

8. When a player has played the ball, any one of the same side who is nearer the opponents' goal-line on their ground is *out of play*, and may not touch the ball himself, or obstruct any other player, until the ball be first played by one of the opposite side, or he have crossed into his own ground.

9. No player shall carry the ball, hold it, throw it, pass it to another with his hands, or lift it from the ground with his hands, on any pretence whatever.

10. All charging is fair; but holding, pushing with the elbows or hands, tripping up, and hacking are forbidden.

11. No player may wear iron plates, projecting nails, or rubber on his boots or shoes.

12. A goal is gained when the ball is *kicked* from the front beneath the uprights and beneath the cross-bar, or in any way passed through from the front, by the side owning the goal.

13. In case of any distinct and wilful violation of these rules of play by one of either side, the opposite side may claim a fresh kick-off.

#### DEFINITION OF TERMS.

A *place-kick* is a kick at the ball while at rest on the ground. The kicker may claim a free space of three yards in front of the ball.

*Ground.* Each side claims as its own that portion of the ground which lies between its goal and the centre.

*Charging* is bringing the body into collision with that of an opponent. The arms, and especially the elbows, must be kept well to the sides, not to violate Rule 10.

*Hacking* is kicking an adversary intentionally.

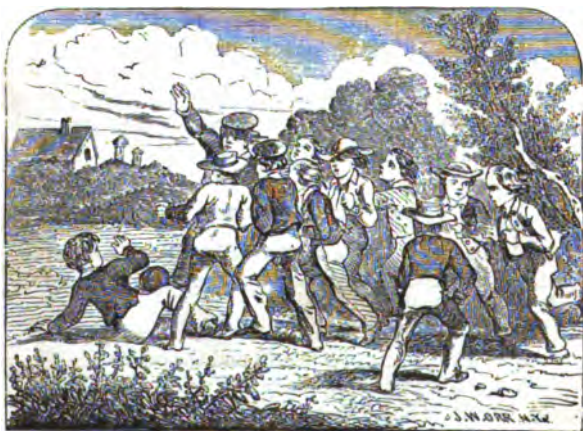
*Tripping* is throwing an adversary by placing the foot,



leg, or any part of the body in the way of an adversary's legs, and thus causing him to fall or stumble.

### *CATCH-BALL.*

This is very similar to the game of nineholes. Instead of bowling the ball into holes, it is thrown in the air, and the name of the player, for whom it is intended, called out by the thrower. If it be caught before it has twice touched the ground, by the player so called on, he loses no point, but throws it up again, and calls upon whom he pleases to catch it. If it be not caught in due time, he whose name is called must endeavor to strike one of the others with it; if he miss, he loses a point, and has his throw up. The remainder of the game, the number of points, and the losers' punishment, are all precisely as in Nine-holes; of the two, it is the better game.





### BASE-BALL.

This, the national game of our country, holds the same place with us that cricket does in England. It is really the old English game of *rounders* brought down to a system, and made into a game suitable for all, from the youngest school-boy to the full-grown man. It can be played by any number of boys, but the proper way is to have two sides, with nine players on each side.

The history of the game commences with the formation of the National Association, inasmuch as the rules previously were crude and irregular; but as it now exists it requires a high degree of physical ability, and the possession of manly character to excel in it.

The theory of base-ball is as simple as that of any field sport in vogue, and therein lies one of its attractive features.

Having selected as level a field as you can find, you mark

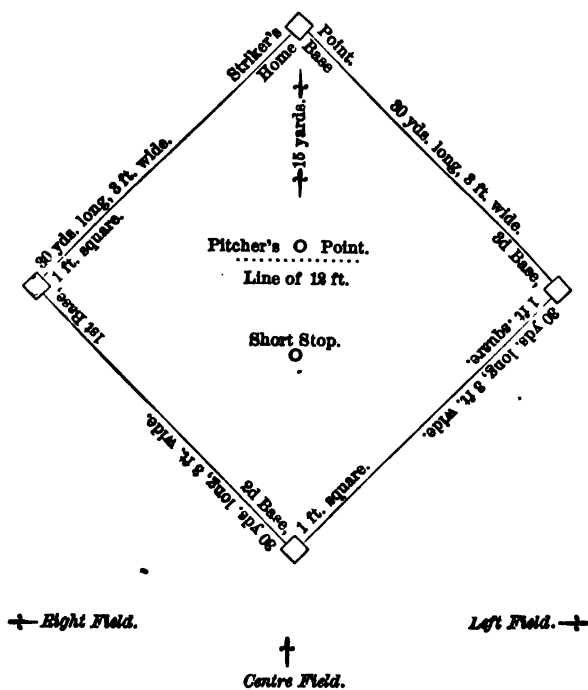
© Scorer.

**Catcher.**

○ Umpire.

**8 feet.**

**3 feet.**



**DIAGRAM OF A BASE-BALL FIELD.**

out your bases in the form of a square, with one corner as the position of your home base, and the other corners for the first, second, and third bases, the first base being on the right of the batsman as he stands at the home base, and the third base on the left.

By looking at the diagram you will see the relative positions. Whoever wins the toss at the outset, can either bat or field first. The batsman takes his position at the home base, on a line drawn through its centre, parallel to one extending from the first to the third base, and extending three feet on each side of it. As soon as he hits the ball he starts for the first base, and is succeeded by the other batsmen in turn. When three of these are put out the fielders take their turns at the bat, and play their innings ; and so on, to the close of the game, which consists of nine innings on a side. If the batsman, after touching successively the first, second, and third bases, reaches the home base, untouched by the ball in his adversary's hands, he is entitled to score one run ; and if he hits the ball so far as to make the four bases before it is returned, he makes a home run. If the game be interrupted or stopped before each side have played five innings, it is drawn. The rest of the game will be found by a reference to the rules.

#### BAT AND BALL.

The form and shape of the bat and ball are regulated by the rules. For ordinary use ash is the best material ; but those who like a heavy bat will take hickory, and for a light bat, English willow is preferable.

#### FIELD POSITIONS.

*Catcher.*—His business is to catch or stop all balls pitched or thrown to the home base, to catch all tips and foul balls, throw the ball swiftly and unerringly to the bases, and keep a watch over the whole field. When a player has made the first base, the catcher gets nearer the striker, so as

to take the ball from the pitcher before it bounds ; and so soon as the ball is delivered, and the player runs from first to second base, he takes the ball before bounding, and delivers it swiftly to the second base, in time to cut off the player before he gets to that base. When the catcher sees several fielders running to catch a ball, he should name the one to catch the ball on the fly, but only, in case of its being missed, take it on the bound.

*Short Stop.*—His duty is to stop all balls that come within his reach, and pass them to whatever base the striker is running to. When necessary, he covers the third base, and backs up the second and third bases, when the ball is thrown in from the field. He must be ready to take foul balls on the bound, when missed on the fly by the pitcher, or third baseman.

*Pitcher.*—His position is behind a line, four yards long, drawn at right angles from the home to the opposite base, at the distance of forty-five feet from the home. He should be chosen for his good fielding, and swift and accurate delivery of the ball, which he must pitch and not throw. The ball must be delivered as near as he can to the home base, to the striker, and high enough to prevent its bounding at or before the base. He should keep his eye out to the bases, and when he sees the players endeavoring to run to the bases, should deliver an accurate and swift ball to the basemen. He should be able to pitch the ball quickly and evenly, and give it at the same time that bias, or twist, which is best to baffle the batsman's blow, and yet is a fair ball at the striker. He should catch, too, if a player endeavors to make the home base while he is pitching, and follow his ball to the home, where he will take it from the catcher.

*Left Field.*—As half, or may be more, of the balls hit are sent in his direction, he should be a sure catcher, as well as a good thrower and runner.

*Centre Field.*—*Right Field.*—These require the same qualities as the other field ; but as few balls go to him, it is usual to put the poorest player in the last-named position.

*Batsman.*—He must not get over three feet from either side of the line drawn through the centre of the home base, and wait the coming of a proper ball; but when a fair ball comes he should strike. When he has hit the ball he should drop, not throw his bat, and make for the first base; for if it be a foul ball the umpire will declare it at once, and he can easily return. The rules, if studied, will speak further of him and his duties.

*First Base.*—He should take a position a little below his base, and inside the line of the foul-ball post, to catch balls he would otherwise miss. The moment the ball is struck, and does not come near him, he must get back to his base, and with one foot on it, be ready to receive the ball from any fielder; because the striker may be put out at the first base without being touched by the ball, provided the baseman, with ball in hand, touches the base before the striker gets there. The moment he has held the ball, he should either send it to the pitcher, or to any other base that players are trying to make.

*Second Base.*—He should play generally to the left and a little back of his base, though he should be guided in it by the customary play of the striker. When the striker reaches the first base, he should return to his base, prepared to receive the ball from the catcher, and be ready to put out the striker by touching him with the ball. On no base, except the first, can the striker be put out by the baseman holding the ball, except when balls are caught on the fly, or are foul, when the player, in returning to the base he has left, may be put out, as at the first base.

*Third Base.*—The same general rules will apply here as to the second base in regard to practice.

#### ON FIELDING.

The fielders should always be able to throw the ball to base from long field; and whenever they stop the ball, they should return it *at once*, either to the pitcher, or to the base-

man needing it. Let each start the moment the ball is struck, so as to take it, if possible, on the fly, and not on the bound. It is easier to take a ball by running forward than backward. You may be deceived by a ball being hit high to long field, and think it will come farther than it will—a ball describing a more sudden curve in its descent than ascent. Practice and a keen eye must strengthen the fielder's judgment on this point.

#### THE UMPIRE AND SCORER.

*The Umpire.*—The position of the umpire is not altogether desirable, for he must displease some one with his decision. But he should not merely be impartial, nevertheless, but strict, in enforcing the rules of the game, and prompt in his decision, giving an opinion in general according to the first impression on his mind, which, in ninety-nine cases out of a hundred, he will find correct. If the point is doubtful, the rule is to decide in favor of the ball. He should call a foul ball instantly; and call out "one strike," and so on through to "three strike," whenever a player persists in refusing fair balls. He must keep his eyes about him, see that the pitcher does not jerk the ball, or have one foot before his position, or in any other way violate the rules; and see that the batsman is on his line. If the striker is off his line, and the ball therefore fall behind the base when struck, the umpire will declare it a fair ball. His position is to the right of, and between the striker and catcher, in a line between the third and home base, unless the striker is left-handed, when he takes the opposite side. If either side try to prolong the game, in order that night may stop it, let him decide it by the last fair innings, or make it a draw. Let him remember that a bound is when it has struck the ground but once, though it may have struck against a tree or other stationary object before.

*The Scorer.*—His duty is very plain. He is the clerk of the game, to set down everything as it is; and therefore he should know the game thoroughly in every point.

The following are the rules adopted by the National Association of Base-ball Players, with the latest amendments:

#### RULES AND REGULATIONS

*Adopted by the National Association of Base-Ball Players, held in New York, December 9, 1868.*

SEC. 1. The ball must weigh not less than five and one-half nor more than five and three-fourths ounces, avoirdupois. It must measure not less than nine and one-half, nor more than nine and three-fourths inches in circumference. It must be composed of India-rubber and yarn, and covered with leather, and, in all match games, shall be furnished by the challenging club, and become the property of the winning club as a trophy of victory.

SEC. 2. The bat must be round, and must not exceed two and a half inches in diameter in the thickest part. It must be made of wood, and may be of any length to suit the striker.

SEC. 3. The bases must be four in number, placed at equal distances from each other, and securely fastened upon the four corners of a square, whose sides are respectively thirty yards. They must be so constructed as to be distinctly seen by the umpire, and must cover a space equal to one square foot of surface. The first, second, and third bases shall be canvas bags, painted white, and filled with sand or sawdust; the home base and pitcher's point to be each marked by a flat circular iron plate, painted or enameled white.

SEC. 4. The base from which the ball is struck shall be designated the home base, and must be directly opposite to the second base; the first base must always be that upon the right-hand, and the third base that upon the left-hand side of the striker, when occupying his position at the home base. *And in all match games, a line connecting the home and first base and the home and third base, shall be marked by the use of chalk, or other suitable material, so as to be distinctly seen by the umpire.*



SEC. 5. The pitcher's position shall be designated by two lines, four yards in length, drawn at right angles to a line from home to second base, having their centres upon that line at two fixed iron plates, placed at points fifteen and sixteen yards distant from the home base. The pitcher must stand within the lines, and must deliver the ball as near as possible over the centre of the home base, and for the striker.

SEC. 6. Should the pitcher repeatedly fail to deliver to the striker fair balls, for the apparent purpose of delaying the game, or for any other cause, the umpire, after warning him, shall call one ball, and if the pitcher persists in such action, two and three balls; when three balls shall have been called, the striker shall be entitled to the first base; and should any base be occupied at that time, each player occupying them shall be entitled to one base without being put out.

SEC. 7. The ball must be pitched, not jerked or thrown to the bat, and whenever the pitcher draws back his hand, or moves with the apparent purpose or pretension to deliver the ball, he shall so deliver it, and must have neither foot in advance of the front line or off the ground at the time of delivering the ball; and if he fails in either of these particulars, then it shall be declared a balk.

SEC. 8. When a balk is made by the pitcher, every player running the bases is entitled to one base, without being put out.

SEC. 9. If the ball, from a stroke of the bat, *first touches the ground, the person of a player, or any other object*, behind the range of home and the first base, or home and the third base, it shall be termed foul, and must be so declared by the umpire, unasked. If the ball first touches the ground, either upon, or in front of the range of those bases, it shall be considered fair.

SEC. 10. A player making the home base shall be entitled to score one run.

SEC. 11. If three balls are struck at, and missed, and the last one is not caught, either flying or upon the first bound,

it shall be considered fair, and the striker must attempt to make his run.

SEC. 12. The striker is out if a foul ball is caught, either before touching the ground, or upon the first bound;

SEC. 13. Or, if three balls are struck at and missed, and the last is caught, either before touching the ground, or upon the first bound;

SEC. 14. Or, if a fair ball is struck, and the ball is caught either without having touched the ground, or upon the first bound;

SEC. 15. Or, if a fair ball is struck, and the ball is held by an adversary on first base, before the striker touches that base.

SEC. 16. Any player running the bases is out, if at any time he is touched by the ball while in play in the hands of an adversary, without some part of his person being on the base.

SEC. 17. No ace or base can be made upon a foul ball; such a ball shall be considered dead, and not in play until it shall first have been settled in the hands of the pitcher. In such cases players running bases shall return to them, and may be put out in so returning in the same manner as the striker when running to the first base.

SEC. 18. No ace or base can be made when a fair ball has been caught without having touched the ground; such a ball shall be considered alive and in play. In such case players running bases shall return to them, and may be put out in so returning, in the same manner as the striker when running to first base; but players, when balls are so caught, may run their bases immediately after the ball has been settled in the hands of the player catching it.

SEC. 19. The striker must stand on a line drawn through the centre of the home base, not exceeding in length three feet from either side thereof, and parallel with the line occupied by the pitcher. He shall be considered the striker until he has made the first base. Players must strike in regular rotation, and, after the first innings is played, the

turn commences with the player who stands on the list next to the one who lost the third hand.

SEC. 20. Players must make their bases in the order of striking ; and when a fair ball is struck, and not caught flying (or on the first bound), the first base must be vacated, as also the second and third bases, if they are occupied at the same time. Players may be put out on any base, under these circumstances, in the same manner as the striker when running to the first base.

SEC. 21. Players running bases must touch them ; and, so far as possible, keep upon the direct line between them ; and must touch them in the following order : first, second, third, and home ; and if returning must reverse this order ; and should any player run three feet out of this line, for the purpose of avoiding the ball in the hands of an adversary, he shall be declared out.

SEC. 22. Any player, who shall intentionally prevent an adversary from catching or fielding the ball, shall be declared out.

SEC. 23. If the player is prevented from making a base, by the intentional obstruction of an adversary, he shall be entitled to that base, and not be put out.

SEC. 24. If an adversary stops the ball with his hat or cap, or takes it from the hands of a party not engaged in the game, no player can be put out unless the ball shall first have been settled in the hands of the pitcher.

SEC. 25. If a ball, from the stroke of a bat, is held under any other circumstances than as enumerated in Section 24, and without having touched the ground more than once, the striker is out.

SEC. 26. If two hands are already out, no player running home at the time a ball is struck, can make an ace if the striker is put out.

SEC. 27. An innings must be concluded at the time the third hand is put out.

SEC. 28. The game shall consist of nine innings to each side, when, should the number of runs be equal, the play

shall be continued until a majority of runs, upon an equal number of innings, shall be declared, which shall conclude the game.

SEC. 29. In playing all matches, nine players from each club shall constitute a full field, and they must have been regular members of the club which they represent, and of no other club, for thirty days prior to the match. No change or substitution shall be made after the game has been commenced, unless for reason of illness or injury. Position of players and choice of innings shall be determined by captains previously appointed for that purpose by the respective clubs.

SEC. 30. The umpire shall take care that the regulations respecting balls, bats, bases, and the pitcher's and striker's positions, are strictly observed. He shall keep a record of the game in a book prepared for the purpose; he shall be the judge of fair and unfair play, and shall determine all disputes and differences which may occur during the game; he shall take especial care to declare all foul balls and balks, immediately upon their occurrence, unasked, and in a distinct and audible manner. *He shall, in every instance, before leaving the ground, declare the winning club, and shall record his decision in the score books of the two clubs.*

SEC. 31. In all matches the umpire shall be selected by the captains of the respective sides, and shall perform all the duties enumerated in Section 30, except recording the game, which shall be done by two scorers, one of whom shall be appointed by each of the contending clubs.

SEC. 32. No person engaged in a match, either as umpire, scorer, or player, shall be, either directly or indirectly, interested in any bet upon the game. Neither umpire, scorer, nor player shall be changed during a match, unless with the consent of both parties (except for a violation of this law), except as provided in Section 29, and then the umpire may dismiss any transgressors.

SEC. 33. The umpire in any match shall determine when play shall be suspended; and if the game cannot be con-

cluded, it shall be decided by the last even innings, provided five innings have been played, and the party having the greatest number of runs shall be declared the winner.

Sec. 34. Clubs may adopt such rules respecting balls knocked beyond or outside of the bounds of the field, as the circumstances of the ground may demand ; and these rules shall govern all matches played upon the ground, provided that they are distinctly made known to every player and umpire, previous to the commencement of the game.

Sec. 35. No person shall be permitted to approach or to speak with the umpire, scorers, or players, or in any manner to interrupt or interfere during the progress of the game, unless by special request of the umpire.

Sec. 36. No person shall be permitted to act as umpire or scorer in any match, unless he shall be a member of a Baseball Club governed by these rules.

Sec. 37. Whenever a match shall have been determined upon between two clubs, play shall be called at the exact hour appointed ; and should either party fail to produce their players within fifteen minutes thereafter, the party so failing shall admit a defeat.

Sec. 38. No person who shall be in arrears to any other club, or who shall at any time receive compensation for his services as a player, shall be competent to play in any match.

Sec. 39. Should a striker stand at the bat without striking at good balls repeatedly pitched to him, for the apparent purpose of delaying the game, or of giving advantage to a player, the umpire, after warning him, shall call one strike, and if he persists in such action, two and three strikes. When three strikes are called, he shall be subject to the same rules as if he had struck at three fair balls.

Sec. 40. Every match hereafter made shall be declared by a single game, unless otherwise mutually agreed upon.

*GAMES WITH BALLS.**FIVES.*

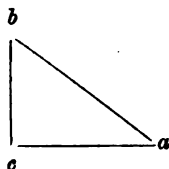
Fives may be played either single-handed or with partners. A good wall must be selected, with a sound flat piece of ground in front of it; a line must be drawn, about three feet from the ground, on the wall; another on the ground, about two yards from the wall; and a third, describing three sides of a square, of which the wall itself will be a fourth, on the ground from the wall, to mark the bounds. The players toss up for innings; the winner begins by dapping his ball on the ground, and striking it against the wall, above the line, and so that it may rebound far enough to fall outside the line on the ground; the other player then strikes it, in the same manner, either before it has touched the ground, or dapped (i. e., hopped) from the ground, more than once; the first player then prepares to receive and strike it at its rebound; and thus the game goes on, until one of the players fail to strike the ball in his turn, before it has hopped more than once, strike it below the mark, or drive it out of bounds. If the party who is in do neither of these, he loses his innings; if the other, then the in-player reckons one, on each occasion, toward the game, which is fifteen. When partners play, the rules are precisely the same; each side keeping up the ball alternately, and the partners taking turns for innings, as one of the other side gets out. After the ball is first played out, on each occasion, it is not necessary to make it rebound beyond the ground line, which is used only to make the player who is in give out the ball fairly in the first instance: that is, when he first takes his innings, or when he plays out the ball again, after winning a point.

*NINE-HOLES OR HAT-BALL.*

Near a wall where the ground is level, dig nine, or a lesser number of holes, according to the number of players,

large enough for a ball to be bowled in without difficulty. Number them, and let each player be allotted a number, by chance or choice, as it may be agreed. A line is drawn about five yards from the holes, at which one of the players places himself, and bowls the ball into one of the holes. The player to whom the hole, into which the ball is bowled, belongs, picks it up as quickly as he can, and endeavors to strike one of the others with it (the latter all run off as soon as they perceive that the ball is not for themselves); if the thrower miss his aim, he loses a point, and is called "a fifer," and it is his turn to bowl; if, however, he strike another, he loses nothing; but the party so struck, in case he fail to hit another with the ball, becomes "a fifer," and it is his turn to bowl. Five or six may be struck in succession, and the ball may be kept up, no matter how long, until a miss be made, when the party so missing loses a point, and bowls. It is also allowed for one player to accept the ball from another, and run the risk of striking a third: thus, if A stand close behind B, and C have the ball in front of B, A may signify by motions that he will take the ball, which is then thrown toward him by C; he catches it, and endeavors to strike B before he can run away; if he miss, he loses a point and bowls. The second bowling is conducted precisely as the first; but he who bowls three times without passing the ball into a hole, loses a point, and if he have lost one before, becomes "a tenner;" he must still go on, until he succeed in putting the ball into a hole; it is his own fault if he bowl into that which belongs to himself. A party who misses his aim a second time becomes "a tenner;" he who loses a third point, "a fiftener;" and when four points are lost, the party stands out. The game goes on until all the players are out but one; the latter wins the game. One of the others then takes the ball in his left hand, places his face toward the wall, and throws the ball over the right shoulder as far as he can. The player who has won stands at the spot where the ball first touches the ground, or, if it be not immediately behind the party

who has thrown it, a line is drawn from the place where the ball daps, to a spot behind the thrower. Thus, suppose the thrower to be at *a*, the ball falls at *b*, a line is drawn to *c*. The winner then throws the ball, from *c*, at the loser's back, three times, as hard as he pleases. The other losers throw in the same manner, one after another, and the winner has his three balls at each of their backs, from the spot where their balls respectively first touch the ground, or in a line with it, as above stated, and illustrated by the diagram in the margin.



This game is also called "Hat-ball," on account of the players using their hats, instead of digging holes, and the ball is tossed into the hats, instead of being bowled into the holes.

### ROUNDERS.

In England, next to cricket, this is one of the most favorite sports with the bat and ball. In rounders, the players divide into two equal parties, and chance decides which shall have first innings. Four stones or posts are placed from twelve to twenty yards asunder, as *a*, *b*, *c*, *d*, in the margin; another is put at *e*; one of the party which is out, who is called the pitcher, places himself at *e*. He tosses the ball gently toward *a*, on the right of which one of the in-party places himself, and strikes the ball, if possible, with his bat. If he miss three times, or if the ball when struck, fall behind *a*, or be caught by any of the players, who are all scattered about the field except one who stands behind *a*, he is out, and another takes his place. If none of these events take place, on striking the ball he drops the bat, and runs toward *b*, or, if he can, to *c*, *d*, or even to *a* again. If, however, the pitcher, or any of the out-players who may happen



to have the ball, strike him with it in his progress from *a* to *b*, *b* to *c*, *c* to *d*, or *d* to *a*, he is out. Supposing he can only get to *b*, one of his partners takes the bat, and strikes at the ball in turn; while the ball is passing from the pitcher to *a*, if it be missed, or after it is struck, the first player gets to the next or a further goal, if possible, without being struck. If he can only get to *c*, or *d*, the second runs to *b* only, or *c*, as the case may be, and a third player begins; as they get home, that is, to *a*, they play at the ball in rotation, until they all get out; then, of course, the out-players take their places. This is the origin of our game of Base-ball.

### CUP AND BALL.

In this game there is no infusion of chance, the whole interest of the game lying in the dexterity of the player.

The cup is a piece of wood or ivory, with a point at one end and a cup—the shallower and smaller the better—at the other. The ball is solid, with the exception of a hole, which ought to be just large enough to receive the point, and no larger. The ball is connected with the stem of the cup by means of a string, which, if possible, should be of soft silk, so as to avoid “kinking,” which is obstructive to all play.

The learner should begin with catching the ball in the cup. He should take the stem by the middle, taking care to hold it as lightly as possible between the ends of the fingers and thumb, and not to grasp it firmly.

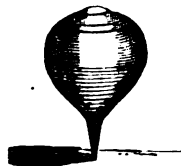




### GAMES WITH TOPS.

#### PEG-TOP.

In this favorite game considerable dexterity may be acquired by practice. A circle, whose diameter is about a yard, is first drawn on a smooth piece of ground (pavement is objectionable for this game), and several players surround it. One volunteers to commence; he throws his top inside the circle, and the others are at liberty to cast theirs at it, so long as it remains within the ring; the moment it rolls out, he may take it up, and peg at those which still remain inside, the object of each player being to split the tops of his companions. If he succeed in any case, he keeps the peg of the split top as the spoil of his victory. If either of the players do not cast his top within the ring, or if he attempt to take it out, or if he fail to set it spinning when he throws, or if it do not spin out, or after it ceases spinning, roll out of the circle, it is called "a dead top," and must be placed in the centre



of the ring for the others to peg at. When it is knocked out again without being split, the player to whom it belongs, takes it up, and plays away as before. Sometimes half-a-dozen dead tops are driven out of the ring by one cast, without any of them being damaged, and indeed, if they be made of good box, it is but rarely that they split. A top with a long peg is best at this game, as it is more calculated to swerve out of the ring after it is spun; a top that sleeps after it is cast, runs the greatest danger, and those that sleep most are heavy bodied tops with short blunt pegs. It is advisable to wind the cord round nearly three parts of the peg, as well as the top, and to use a button at the end instead of a loop. Another way is for the person who strikes a top out of ring to take the top so struck.

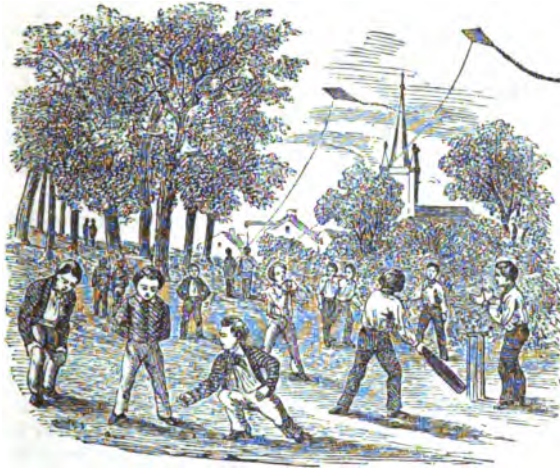
#### WHIP-TOP.

This is an excellent amusement. The top is easily set up by twirling it with both hands on a smooth surface, and



applying the whip with gentleness at first, increasing the vigor of the blows, as the top gets firm on its peg. The only games we have ever seen with whip-tops, are "races" and "encounters;" in the former, the object is to flog the top to a certain distance first;

in the latter, the tops are whipped against each other until one is knocked down. The best material for a whip, at this capital sport, is an eel-skin; it far surpasses cord, or leather thongs.



### *CRICKET.*

Cricket is played by eleven persons on each side, though a less number is sufficient. Two umpires are to be appointed in order to settle all disputes that may arise ; they are to take their stations at each wicket, and should be well acquainted with the laws of the game. The umpire at the striker's wicket should be behind him, so as not to be in the way of the players ; and the umpire at the bowler's wicket, directly behind it, to see that the striker does not strike the ball with his leg.

#### **BATS, BALLS, WICKETS, ETC.**

The bat should not be higher than twenty-one inches in the pod, and four inches and a quarter in the widest part; this is the size for men; boys must, of course, have bats in proportion to their size and strength.

The ball, for the use of men, should weigh five and three-quarter ounces; for youth, however, it should be lighter.

Full-sized wickets are three stumps, which are sufficiently long to leave twenty-seven inches out of the ground, with a bail eight inches long, to fit the top. These, like the bat and ball, must be decreased in size for the young cricketer. They should be placed directly opposite to each other, at the distance of twenty-two yards for men, but varying according to the size of the player.

The bowling-crease should be in a line with the wicket, and have a return crease.

The popping-crease should be four feet from the wicket, and exactly parallel to it.

#### THE BOWLER.

Bowling is a very important part of the game, and requires great steadiness. Bad bowling is often the cause of losing a game. A bowler should not be too systematic, but vary his balls faster or slower, according to the peculiarities of the striker. The bowler and his partner at the opposite wicket should have a secret sign, by which they may hint to each other the propriety of varying the direction or swiftness of the balls. The mode of bowling most generally approved of, is to hold the ball with the seam across, so that the tips of the fingers may touch; it should be held with just a sufficient grasp to keep it steady; by a turn of the wrist, it may be made to cut or twist after it is grounded, which will frequently perplex expert players.

#### THE STRIKER, OR BATSMAN.

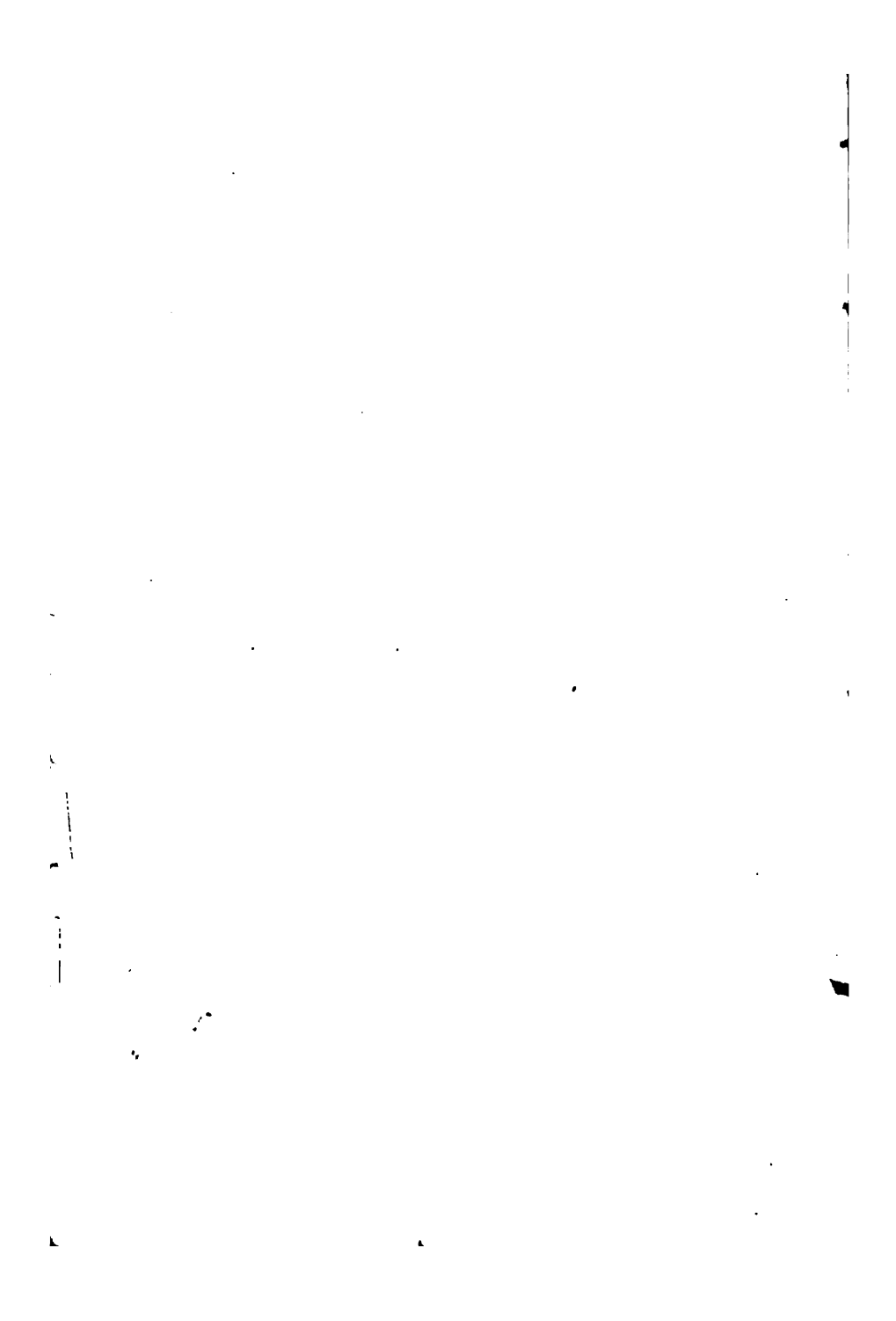
The striker should always be ready for running; when his partner is about to strike, he should stand before the popping-crease, but he must be cautious not to leave the ground before the ball is out of the bowler's hand, for if he do, the bowler may put down his wicket, and he will, of course, be out. As soon as the ball is delivered, the striker may follow it, but should not run too far, so that, if no runs



**STRIKING.  
WICKET-KEEPER.**



**BOWLER.  
ON GUARD.**



be obtained, he may return in time to save his wicket. The bat should be kept on the outside of the opposite partner, and care taken not to run against him.

#### THE WICKET-KEEPER.

The wicket-keeper should not suffer the striker to move from his ground without knocking down his wicket, which is called "stumping out."

#### THE SHORT-SLIP.

The short-slip should stand so as to reach within two feet of the wicket-keeper; if the latter should go from the wicket after the ball, the short-slip should take his place until his return; but no player should take the ball before the wicket-keeper, provided it be coming straight to him.

#### THE POINT.

Point should place himself in the popping-crease, about seven yards from the striker. In backing up, he should take care to give the slip sufficient room.

#### LEG.

Leg should stand a little back from the straight line of the popping-crease.

#### LONG-STOP.

Long-stop should stand a proper distance behind the wicket, to save a run, if the ball should not be stopped by the striker or wicket-keeper. The person who is placed in this situation should not be afraid of the ball when bowled swiftly. He should also be able to throw in well, as it is not only to the balls that pass the wicket-keeper, but to such as are just tipped with the edge of the bat, that he will have to attend. He must also be attentive in backing up. This is a very important position.

#### THE LONG-SLIP TO COVER THE SHORT-SLIP.

This player must stand about the same distance from the



wicket as the long-stop, in a line with the striker, between the point and the short-slip.

#### COVER POINT AND MIDDLE-WICKET.

This player's place is on the off side, so that if the ball should be hit to the point and middle-wicket man, and missed, he will be in readiness to receive it.

#### THE LONG-FIELD OFF SIDE.

He should be placed on the off side, between the middle wicket-man and the bowler, at a considerable distance in the field, so as to cover them. It is desirable to appoint a person to this situation, who can throw well and judiciously.

#### LONG-FIELD ON SIDE.

Long-field on side is at some distance wide of the bowler's wicket, so as to prevent a second run.

If there be more players, they may be placed to back up, or save runs, in different situations about the field.

#### LAWS OF CRICKET.

The bowler should deliver the ball with one foot behind the bowling crease, and within the return crease. He should bowl four balls before a change of wickets, which he is to do but once in the same innings. He must be careful to toss the ball in such a way that the striker can play at it; for if he should toss it above the striker's head, or out of the bounds of the bowling-crease, the party which is in shall be allowed one notch, to be put down to the byes; and such ball is not considered as one of the four balls. When the umpire calls "No ball," the hitter may strike at it, and get all the runs he can.

The striker, or batsman, is always out when the ball is knocked off the stump; when a stump is bowled out of the ground; or, if the ball should, from a stroke over or under his bat, or upon his hands (but not his wrists), be held be-

fore it touches the ground, even if it should be pressed to the body of the catcher; or if, while he is striking, or at any other time when the ball is in play, both his feet are over



the popping-crease, and his wicket put down, except when his bat be on the ground within it. Likewise, if he hit down his own wicket; or, if either of the strikers prevent a ball from being caught, the striker shall be out; or, if the ball be struck up, and the hitter wilfully strike it again; or, if, in attempting to run a notch, the wicket be struck down by a throw, or with the ball in hand, before his foot, hand, or bat is grounded over the popping-crease: If the striker remove or take up his ball while in play, without being requested by the opposite party; or if, with his leg or foot, he stop a ball which has been pitched in a straight line to the striker's wicket. If "A lost ball" be called, the striker shall be allowed six notches. If the players have crossed each other in running, he that runs for the wicket which is

put down, shall be out; but if they have not crossed each other, he that has left the wicket which is put down, shall be out.

When a ball is caught, no notch shall be reckoned. When a striker is run out, the notch they were running for shall not be reckoned. While the ball is kept in the bowler's or wicket-keeper's hand, it is considered no longer in play, nor are the strikers bound to keep within their bounds; but if a player should go out of his ground, with intent to run, before the ball is delivered, the bowler may put him out. If a striker be hurt by a ball, or otherwise, during his play, he may retire from his wicket and continue his inning; and another person may be permitted to stand out for him, but not go in. If any player should stop the ball intentionally with his bat, it shall then be considered dead, and the opposite party may add five notches to the score.

If the ball be struck up, the striker may guard his wicket either with his bat or his body. If the striker hit the ball against the wicket of his partner when he is off his ground he is out, if it have previously touched the bowler's or any of the field-men's hands, but not otherwise.

Two minutes are allowed for each man to come in, and fifteen minutes between each innings; when, upon the umpires calling "Play," the party refusing to play shall lose the match.

The wicket-keeper shall not take the ball before it has passed the wicket, for the purpose of stumping, and if any part of his body is in front of the wicket when the batter is bowled out, he shall not be out.

The umpire should observe the situation of the bowler's foot when he delivers the ball, and if it be not behind the bowling-crease, and within the return crease, he shall call "No ball." If the striker should run a short notch, the umpire shall call "No run." The umpire at the bowler's wicket has a right to be first applied to for his decision on the catches.

## SINGLE WICKET.

The game of Single Wicket is not so interesting as that of Double Wicket; but it may be played by almost any number of persons, though it is seldom played with more than four or six on a side. The business of a bowler and striker is nearly the same as in Double Wicket.

When the striker runs to the bowler's wicket, and knocks the bail from off two stumps placed there, with his bat, and returns to his own wicket without having it knocked down by the ball, he is entitled to count one notch. After he has run one notch, if he start for another, he must touch the bowling stump and turn again, before the ball crosses the play, to entitle him to another notch. He is entitled to three notches for a lost ball.

If four, or a less number are at play, then they should make all hits before the wicket, with bounds, etc., and not move off the ground, except by agreement. Where there are more than four players on a side, there should be no bounds; and all hits, byes, and overthrows should be allowed. It is, of course, to be understood, that the bowler must bowl at the usual distance from the wicket. No more than one minute is to be allowed between each ball. When the striker hits the ball, one of his feet must be on the ground, and behind the popping-crease; otherwise the umpire shall call "No hit." The field's-man must return the ball, so that it shall cross the play between the wicket and the bowling stump; or between the wicket and the bounds; the striker may run till the ball shall be so returned. These are the principal rules and regulations adopted by the most experienced Cricket-players, at the game of Single Wicket. The distance between the wickets is precisely the same as at Double Wicket, consequently, the runner has twice the ground to run, in obtaining each notch; but we would suggest, that this evil might be remedied by running only a little more than half the usual distance: by this method, Single Wicket will be rendered much less fatiguing, and far more lively and amusing, at least to the BATSMAN.

### RACKETS.

The ball used in rackets is smaller and harder than that used in fives; it barely exceeds an inch in diameter, and is as hard as the nature of the materials will allow, the two qualities specially required of it being that it shall be perfectly spherical and shall possess extreme elasticity.

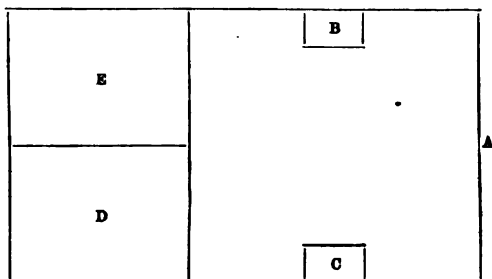
The bat, or racket, must be familiar to most of our young readers; those, however, who are unacquainted with its shape and construction will find it accurately made in any toy store. The cross network is composed of strong gut, and the total length of the bat is about thirty inches.

The wall against which the ball is struck is marked out as in fives, with the addition of another line about ten feet from the ground, above which the ball must strike when served. The floor is marked out into five divisions, which will be fully explained below. There is usually a kind of gallery at the back for spectators and the marker. The walls should be covered with a smooth hard plaster, and the floor should be of some firm concrete and perfectly level, and both floor and walls should be painted *black*, as a background for the white ball, which even at the best it is often hard enough to follow.

The players may be either two or four. When two play, having tossed for the lead off, the server stands in the small compartment marked *B*, while his opponent takes his stand in the large one marked *D*. In serving, the ball must be made to strike the wall at *A*, above the upper line mentioned above, and must fall *within* the compartment *D*.

If the player in *D* succeed in hitting the ball at the first hop, and driving it fairly back to the wall, striking above the lower line, the game goes on, each striking it alternately until one fails, the ball now being only required to strike the wall above the lower line, and being quite unrestricted as to the place where it takes the ground. If the server fail, he loses his turn, and his opponent takes his place; if the

second hand fail, the server counts one to his game, which is reckoned in all things just as in fives. The serving takes place alternately from B and C—the second hand standing at D for B, and E for C.



The ball may strike the side and end walls either before or after striking the playing wall at A; but the roof and the gallery, if there be one, are considered out of bounds, and count to the striker for a miss. A good player makes great use of the walls, and will utterly confound and bewilder the novice by driving the ball into corners, where it either flies about in the most incomprehensible manner or falls most disappointingly dead to the ground. Thus it will be seen that in rackets, more even than in fives, a player's real strength lies chiefly in the power of serving a series of difficult or actually impossible balls.

There are many other "dodges" which a good player practises, which time would fail us to enumerate, and which, indeed, hardly come within the scope of these short notices, which are not intended as exhaustive treatises on the various games for the use of experts, but as an introduction to their theory and practice for the use of learners and unformed players.

One trick of the racket may, however, be mentioned as not very difficult to acquire and yet extremely valuable in play. By a quick action of the wrist as the ball takes the

racket, drawing the network across the ball, a very considerable spin or bias may be imparted to it, which will cause it not only to fly off the walls at unexpected angles, but to prove so erratic in its rebound from the ground as to put all calculation at defiance and baffle the most expert player.

The first thing a beginner has to learn in handling a racket is to stand far enough away from the ball; it is the almost invariable fault of a novice to get too near for fair striking. The second, perhaps, is to keep cool and not be in too great a hurry to strike. This is perhaps a too common fault with most players; they fly about and dash frantically at almost every other ball; whereas a really fine player, as a rule, takes the ball as late as possible, and hardly ever seems to be in a hurry, generally taking the whole affair with the most provoking calmness and deliberation. To this point of perfection, however, it is only given to the few to attain—we point it out as the real standard of excellence.

Some attention to dress is necessary: light flannel jersey and trousers, and canvas shoes, is the regulation dress. Ordinary base-ball habiliments will do for the first, and any pair of close-fitting light shoes or slippers will do for the second; but the regular shoes are very inexpensive, and need not be a cause of alarm at home. Ordinary boots and shoes with thick soles and heels are simply inadmissible; first, because they would cut the paving of the court to pieces; and secondly, because they are sure to bring their wearer to grief sooner or later, by slipping up and letting him down after a fashion to which a heavy fall on the ice is mere child's play, and to the imminent danger of breaking half the bones in his body.

The racket is very liable to warp, and so to play untruly; it should always be kept, if possible, under a weight. When a racket has warped so much as to become troublesome, it can always be restored by being pressed in a frame made for the purpose; but a little care will render this unnecessary for a long time.

## SHINNY, HOCKEY OR BANDY.

This is perhaps, next to football, the best of our open-air winter games, and is strongly recommended to our young readers, as a very efficient substitute for that nobler sport. The spirit of the game is pretty much the same as that of football, the object being to strike a ball through a goal marked by two uprights, the principal difference being that the instrument of propulsion is a stick instead of the foot, and that the ball is smaller and of a different make.

The game *may* be played by a very few, but at least six or eight are necessary to give it any real interest. From ten to a dozen on a side can play with advantage if the space be not too confined; but a game with only six or eight on a side gives more room for individual skill, and is therefore preferable. Under all circumstances a *crowded* game is to be avoided, for the game then ceases to be a contest of skill, and degenerates into a mere chance medley, in which all refinement of play is rendered impossible by the sheer press of numbers, and brute strength and reckless hard pounding bear down all opposition. Another objection may be mentioned—of more weight, perhaps, with parents than with boys themselves, but which the latter might well take into some consideration—that is, the extremely dangerous nature of the game thus played. In the midst of a grand scrimmage, where a score or so of players are plying their hockey sticks vigorously in the confined space of a few square yards, it cannot be but that some blows more or less awkward must be inflicted upon the heads and faces of those engaged.

The game is played with a solid india-rubber ball from two to two and a half inches in diameter; and the players, each with a hooked stick or "hockey," take opposite sides, and try to drive the ball through each other's goals. The goals, which should be marked each by two poles about ten feet apart and eight feet high, with a cord joining their tops, may be placed at from eighty to a hundred yards apart, and boundaries should be marked at the sides by flags or posts as



in football, leaving a space between them of about forty yards. To put the matter more exactly, the ground for a game with a dozen on a side should be about a hundred yards long by forty broad, while for numbers less than this it should be proportionately contracted.

There is much variety of opinion as to the best form of hockey-stick, nearly every player of any pretensions having his own fancy; but all kinds of hockey may be classed under two heads—those with a small hook and those with a large one, the difference between them being much the same as that between a rapier and a cavalry broadsword. As may be supposed, the better players mostly prefer the lighter and more wieldy though less powerful weapon, just as a first-rate fencer would prefer a light straight sword to a cutlass.

In choosing a hockey, the young player should be careful not to overweight himself; all the real work of the game is done by pure *wrist-work*; the hockey, therefore, must not be of a greater weight than he can easily manage.

The rules of the game are few and simple; those for play are as follows:

1. The choice of goals shall be decided by tossing, and the side winning the toss shall start the ball from a spot ten yards in front of their goal.
2. The ball may only be *played* with the hockey; it shall, however, be lawful to stop the ball with the body or legs, but not with the hands.
3. A goal is gained when the ball is *played* through between the posts and under the cord by the opposing party, or in any way passed through by the side owning the goal.
4. No player may strike the ball backhanded; in every case the player must play facing the opponent's goal.
5. A player is not permitted to loiter near the adversary's goal, but may be required to retire, while not playing at the ball, to a distance of at least twenty-five yards.



### GAMES WITH MARBLES.

There are three ways of shooting a marble. 1. *Trolling*, which consists in projecting the marble so that it rolls along the ground until it strikes the marble at which it is aimed; 2. *Hoisting*, where the marble is shot from, at or above the level of the knee, while the party stands; and, *Knuckling down*, where the player shoots with the middle knuckle of his forefinger touching the ground, but makes his marble describe a curve in the air on its way to the ring. A boy has to be a good player, a "dabster," as they say, to knuckle down well.

To shoot a marble properly, it must be held between the tip of the fore-finger and the first joint of the thumb, resting on the bend of the second finger, and propelled forward by suddenly forcing up the thumb-nail. Some boys place it between the bend of the first finger and the thumb joint. This is called "shooting cunnethumb," and not only subjects those who do it to the ridicule of their associates, but tires the thumb very much.

## KNOCK-OUT.

Two or more may play at this game. He who begins, throws a marble gently against a wall, so that it rebounds to a distance not exceeding a yard; a second player throws another marble against the wall, endeavoring to make it rebound, so as to strike or come within a span of the first; if he can do neither, the first player takes up his own marble, and, in turn, strives to snop or span that of the second. The marble that is thus snopped or spanned, is won, and the winner begins again. Where only two play, it is best to knock out two or three marbles each, alternately, before they begin to use those on the ground. In this case, a player may win his own marbles, as they are common stock when down, and take up which he pleases, to play with.

## ARCH BOARD.

This game is called "Nine-holes," also "Shoot through the Files;" it has various names, and is sometimes played with iron bullets instead of marbles. The marbles are bowled at a board set upright, resembling a bridge, with nine small arches, all of them numbered; if the marble strike against the sides of the arches, it becomes the property of the boy to whom the board belongs; but, if it go through any one of them, the bowler claims a number equal to the number upon the arch it passed through. We have seen the boards, in this game, marked above some of the arches with nihils, in this order:—5, 0, 1, 2, 0, 3, 0, 4, 0. In some places, where there are no nihils on the board, and the numbers go beyond five, the bowler not only loses his marble, if it strike against the sides of the arches, but also gives the board-keeper a marble each time he bowls.

## RING-TAW.

The rules of Ring-taw vary in different places; the following are the most general:—A circle is drawn, into which each party places as many marbles as may be agreed on. A

line, called the offing, is then drawn at some distance, from which each in turn shoots at the ring. Shooting a marble out of the ring, entitles the shooter to go on again, and thus the ring may be sometimes cleared by a good player, before his companion or companions have a chance. After the first fire, the players return no more to the offing, but shoot, when their turn comes, from the place where their marbles rested on the last occasion. Every marble struck out of the ring, is won by the striking party; but if the taw at any time remain in the ring, the player is not only out, but if he have previously in the course of the game struck out any marbles, he must put them in the ring again. And if one player strike with his taw the taw of another, the player whose taw is so struck, is out; and if he have previously shot any marbles out of the circle, he must hand them over to the party by whose taw his has been so struck.

#### THE PYRAMID, OR SHOOT THE DIE.

A small circle is drawn on the ground, within which one player builds a pyramid, by placing three marbles triangularly, and a fourth in the centre, on the top of them, or a die. Any other player may then shoot at the pyramid, at an agreed distance, by giving, for each time of shooting, to the one who keeps the pyramid, a marble. If the shooter strike the pyramid with his taw, as many of the marbles composing the pyramid as may be driven out of the circle, belong to the shooter, and the pyramid is constantly to be kept up complete by its owner. If a die is placed on the top, the striker is paid the number of the die that is uppermost. This is a good indoor game; variety and additional interest may be given to



it, by each player taking the office of pyramid-keeper at stated intervals.

#### INCREASE-POUND.

This is superior to any other game with marbles. It differs from "Ring-taw" in the following particulars:—If, previously to any marble or shot being struck out of the ring or pound, the taw of one of the players be struck by the taw of another (except that of his partner), or in case he shoot his taw within the pound, in either case, he puts a shot in the ring, and before either of the others play, shoots from the offing and continues in the game; but if the first of these events occur after one or more shots have been struck out of the pound, if he have previously, during that game, obtained any shots himself, he hands them over to the party who has struck him, and also puts a shot in as before, previously to his shooting from the offing; but if he have previously obtained no shots during the game, he is put out of the game entirely, or "killed," by his taw being so struck; and again, if after a shot or shots have been struck out of the pound, his taw get within it (on the line is nothing), he puts his shots, if he have obtained any, with an additional one, into the pound, and shoots from the offing; but if he have not obtained a shot or shots after his taw so remains within the ring, "or gets fat," as it is called, he is "killed," and stands out for the remainder of the game. When there is only one marble left in the ring, the taw may then remain inside it, without being "fat" at this game. The players seldom put more than one marble each in the ring at first.

#### HOLES.

Three small holes are dug, about a yard and a half asunder; a line is drawn about two yards from the first hole, from which the players begin the game. Chance decides who shall have the first shoot; the object is to drive the marble into the first hole; if this be done the player shoots again,

at the distance of a span, towards the second. If, however, he miss the hole the other player begins, and each shoots, alternately, as the other misses. After having shot the marble into a hole, the player is allowed, if his adversary's marble be near, to drive it with his own as far as he can, and if he strike it to shoot again. The game is won by the player who gets into the last hole, in the following order:—first hole, second, third,—second, first,—second, third. The loser places his knuckles at the first hole, the winner shoots as near to it as he can from the line, and fires three times, from the place where his marble rests, at the loser's knuckles.

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Here are a few hints on taw-shooting. Do not aim directly at the marble, because you are always apt to use a little too much strength, and then the taw flies over the marble, and misses it altogether. Aim at the ground about a quarter of an inch in front of the marble, and then you will seldom miss. Even if you should strike the ground half an inch short, no harm will be done, the taw being sure to touch the top of the marble as it leaps from the ground; and, if you should shoot a little too low, your taw will alight plump on the marble, and drive it to a distance. If you can possibly avoid it, do not let your taw *roll* towards the marble which you mean to strike, because any impediment or obstacle will be sure to turn it aside.

It is worth every boy's while to practise taw-shooting, if only for five or ten minutes a day. He will soon gain an amount of precision and confidence which will thoroughly repay him for the trouble which he has taken. It must be borne in mind, that the reputation of being a certain shot at marbles is most useful. Your adversaries will be afraid of you. They will not dare to take any liberties with the game. They will keep themselves at a respectful distance from your taw for fear of being killed; and so you may frighten them away from the ring, and pick out all the marbles at your pleasure.

## HARE AND HOUNDS.

Choose among your playfellows one who is swift of foot and ready in resource to take the part of the hare ; and then, when you are all assembled, the game proceeds in the following manner : The hare, who provides himself with a pocketful of paper cuttings, has ten minutes' law given him, and away he starts. As soon as he is some distance from the hounds, he drops the paper cuttings here and there in his course, as a guide to the hounds. The paper cuttings are technically called "the scent." At the expiration of the term allowed for law, the hounds follow, at the top of their speed, in the direction indicated by the scent ; and the game is over when the hare is finally caught,—which, if he be active and ingenious, may take an hour or more. It is usual to elect a huntsman and whipper-in from among the fastest runners. These direct the hunt, call together the hounds, and generally superintend the arrangements. Sometimes the hare is provided with a horn, which he blows when he considers he is far enough from his pursuers. The huntsman, too, generally carries a white flag, and the whipper-in a red one ; and when the scent is struck, off they all go, till they either find the hare, or proclaim him lost. It is, in this case, the huntsman's part to seek the trail of the hare, while the whipper-in keeps his hounds well together till the track is refound. Then Tally ho ! and follow the white flag, wherever it goes, till the hare is fairly run to earth. If a long course be taken by the hare, it is as well that he should provide himself with a pocket compass, or some other means of finding his way back to the starting place.

## HUNT THE STAG.

This game differs only from the last in the fact that the stag is in sight of the hounds, instead of being hunted by scent—that is, by the pieces of paper dropped on his course. The stag has a minute's start.



### *SPORTS OF AGILITY AND SPEED.*

Many of the previous sports with balls and tops are in part games of agility and speed, and so also are several of those which will be found among the Miscellaneous Minor Sports; but the following pastimes are exclusively games either of speed or agility, for which no implements are necessary.

#### LEAP-FROG.

This is a most excellent pastime. It should be played in a spacious place, out of doors if possible, and the more there are engaged in it, provided they be of the same height and agility, the better is the sport. We will suppose a dozen at play:—Let eleven of them stand in a row, about six yards apart, with all their faces in one direction, arms folded, or their hands resting on their thighs, their elbows in, and their heads bent forward, so that the chin of each rests on his breast, the right foot advanced, the back a little bent, the shoulders rounded, and the body firm. The last begins the sport by taking a short run, placing his hands on the



shoulders of the nearest player, and leaping with their assistance (of course, springing with his feet at the same time) over his head, as represented in the cut. Having cleared the first, he goes on to the second, third, fourth, fifth, etc., in succession, and as speedily as possible. When he has gone over the last, he goes to the proper distance and places himself in position for all the players to leap over him in their turn. The first over whom he passed, follows him over the second, third, fourth, etc.; and when he has gone over, the one who began the game places himself in like manner for the others to jump over him. The third follows the second, and so on until the parties are tired.

#### PRISONERS' BASE.

Prisoners' Base is truly a capital game for cold weather. The best number to play at it is six or eight on each side, but there is no objection to more or fewer players. The choice of partners is decided by chance; a line, ten or twelve yards in length, is drawn about a dozen yards from a wall; other lines are drawn at each end of the first, reaching thence to the wall, and the third from the middle of the first line to the wall; one party takes possession of the bounds on one side of this middle, and the other set of players takes the bounds on the other side of it. Two prisons are also marked in a line with each other, at from one to two hundred yards (as convenience will permit) from the front of the bounds; the prison belonging to one party must be opposite the bounds of the other. The game is now commenced by a player from one side running out midway between the bounds and prisons; a player from the other side immediately follows, and he may be pursued by one of his adversaries, who in like manner may be followed by a player from the side which began the game, and so on; both parties being at liberty to send out as many as they think fit. The object of each player is to come up with, or intercept and touch any player of the opposite side, who has left the bounds before him; he is not at liberty to touch any that have started

after him, it being their privilege, on the contrary, if they can, to touch him before he can get back within his bounds again. A player is allowed to touch one of the opposite party only each time he quits bounds, and after having touched an adversary, he is exempt from being touched on his return to bounds. Every player who is touched, goes to the prison belonging to his party, where he must remain until one of his own side (who must start from bounds after the prisoner has been within the line of the prison) be able to reach him, without being touched in his run from bounds to prison, by any of the opposite party who may have left their bounds after him. When thus released, neither he nor the player who has relieved him is to touch or be touched in their return to bounds again. The game is won by that side which has all the players of the other in prison at the same time.

#### SADDLE MY NAG.

Two players toss up for choice of partners; six or eight on each side is the best number; after choosing, the two leaders toss up for innings, he who loses then ranges himself and his associates in the following manner:—One player places himself almost upright, with his hands resting against a wall or tree, a second puts his head against the back of the first, the third against the back of the second, and so on until they are all ranged. They must either hold by the pants of the player who is before them, cross their arms on their breasts, or lean them on their knees. One of the winning party now begins by taking a run, placing his hands upon the back of the outer player on the other side, and leaping as far forward on the range as he possibly can, in order to afford room for his partners behind him, who follow in succession, until all are on the backs of the other party. If they can all remain on without touching the ground with the hand or any other part, while the leader counts twenty, or if any of the other party sink beneath the weight, or touch the ground with their hands or knees to support themselves, the riders keep.

their innings, and go on again. If, on the contrary, or in case there be not room enough for them to leap on, or they cannot keep on the backs of those who are on before them, they lose, and the other party become riders, and they nags.

#### PUSS IN THE CORNER.

This is a very simple, but at the same time, a very lively and amusing game. It is played by five only; and the place chosen for the sport should be a square court or yard with four corners, or any place where there are four trees or posts, about equidistant from each other, and forming the four points of a square. Each of these points or corners is occupied by a player; the fifth, who is called Puss, stands in the centre. The game now commences; the players exchange corners in all directions; it is the object of the one who stands out, to occupy any of the corners which may remain vacant for an instant during the exchanges. When he succeeds in so doing, that player who is left without a corner becomes the Puss. It is to be observed that if A and B attempt to exchange corners, and A gets to B's corner, but B fails to reach A's before the player who stands out gets there, it is B and not A who becomes Puss.

#### FOLLOW MY LEADER.

Without a bold and active leader this sport is dull and monotonous; with one possessing the necessary qualifications it is quite the contrary. Any number may play at it. A leader is fixed on, and the other players range themselves in a line behind him. He commences the sport by some feat of agility, such as leaping, hopping, or climbing, and his followers then attempt to perform it in succession. He then goes to another trial of skill; the others, or so many of them as are able to do so, follow his example, and thus the sport proceeds until the parties think fit to cease. The most nimble and active should, of course, be chosen for a leader; he should perform feats of such difficulty as to render the sport

interesting, at the same time avoiding such as he knows can only be undertaken by himself, or by one or two of his followers. If one boy can perform a feat which those who are placed before him in rank fail in attempting, he takes precedence of them until he is, in like manner, excelled by any of those who are behind him.

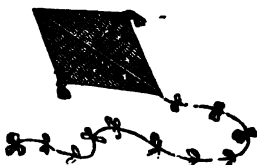
#### TAG OR TOUCH.

This is a sport of speed. Six or eight is the best number to play at it. One volunteers to be the player, who is called Touch; it is the object of the other players to run from and avoid him. He pursues them all; or, if he think fit, singles out an individual, and follows until he comes up with and touches him. The player so overtaken becomes Touch, and then endeavors to get near enough to lay his hand upon one of the rest. This is an active and amusing game for boys in cold weather. It is sometimes called Touch-iron or Touch-wood; in these cases, the players are safe only while they touch iron or wood, as may be previously agreed. They are liable to be *touched* only when running from one piece of wood or iron to another.

#### CROSS TOUCH.

This is a mere modification of the preceding. Touch calls out the name of the player he intends to chase, and sets off after him; the other players then run across between touch and the fugitive. Each time a player crosses between the two, touch must leave the original chase and follow the player who has crossed, and so on, perhaps chasing in turn every individual player before he can effect a capture.

The same remark as to numbers holds good here as in the preceding.



*SPORTS WITH TOYS*

## THE POP-GUN.

The Pop-gun is made of a piece of wood, from which the pith has been taken; a rammer must be made, with a handle of a proper length, which should have a shoulder to prevent the slender or ramrod point going the entire length of the gun; the pellets are made of moistened tow or brown paper. Put one into one end of the gun, push it with the rod to the other, and then placing a second pellet at the end where the first was inserted, push that toward the opposite end, and it will drive the first pellet out with great force. Pop-guns are also made with quills, the pellets for which are cut by the quills out of slices of raw potato.

## THE SUCKER.

Cut a circular piece out of stout leather; bore a hole through its centre and pass a string, with a knot to prevent the end escaping, through this hole. Soak the leather well in water before you use it; when thoroughly soaked, place the leather on a stone, press it well down with your foot, and then taking the string, you may, by your sucker, raise a considerable weight.

## THE HOOP.

Everybody knows how to roll the Hoop in the usual way; several pairs of tin squares are sometimes nailed to the inner part of the hoop, which produce, in the opinion of some boys, an agreeable jingle. There is no horse, however well trained, which obeys the hands of the rider with such precision. There is no ship, with the best pilot, which so correctly follows the guidance of its rudder. Here is a hoop, ruled by a stick, which manœuvres it and drives it over the ground in all directions,—to the right, to the left, straight on, backward, forward, describing a curve, a broken line, a circle,



a triangle, or, in a word, all the series of geometrical figures. Many players can contest together with their hoops, and challenge each other, to know who shall drive his hoop the longest time without getting out of breath, or who shall first reach a goal agreed on. In this latter case, all the players taking part in the contest should stand together on the same line, and start at a given signal. Lastly, I shall indicate one of the most amusing exercises with the hoop. When the players are numerous, they divide themselves into two parties, each armed with his hoop and stick. The two parties place themselves opposite each other, leaving between them a convenient space; and further, each player leaves between himself and his companion on either side, a space wide enough for another player to pass easily between. These precautions taken, every one being at his post, with his stick in hand, and his hoop resting on the ground, ready to start, the two parties, at a given signal, set out at the same moment to meet one another, each player endeavoring to steer his hoop between two others, in such a way as neither to jostle against the hoops on the right or left-hand sides, which meet him in the opposite

direction. When the two parties have thus changed sides, and have arrived at the extremity of the bases, they turn round, and players and hoops again cross one another, resembling a little war, in which each party counts his wounds, by the number of sticks and hoops lying scattered on the field of battle.

The hoop is, like the skipping rope, one of the best kinds of exercise for giving strength and suppleness to the limbs. The hoop was known to the ancients, and took part in the public games. But it appears that they did not make it turn on its axis as we do, but restricted themselves to swinging it round their heads, and throwing it up, and receiving it on a little metal rod. The hoop they used was made of metal, to which many rings were attached. According to the testimony of an ancient author, the movement given to the hoop with the metal rod was sometimes so rapid, that the noise of the rings was not heard; at other times it was swung with less violence, so that the sound of the rings produced an agreeable sensation on the ear. The author wishes without doubt to show that this game with the hoop was looked upon as an exercise capable of contributing to the health.

#### THE PEA-SHOOTER.

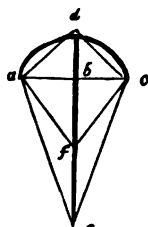
By means of a tube of tin or copper, a pea may be propelled from the mouth, by the mere force of the breath, to a very considerable distance. The natives of Macouslie, with a cane tube about twelve feet long, propel arrows with their breath, with such force and dexterity as to bring down different sorts of feathered game.

#### THE KITE.

To construct the Kite, you must, in the first place, procure a straight lath of deal for the upright, and a thin hoop or a pliant piece of hazel for the bow or bender. Fasten the bender by its centre, with string, to the upright, within



a little distance of its top; then notch the two ends of the bow, and fasten them to the upright by a string, which is made fast at each of the ends, and turned once round the upright as *a, b, c*; the string must then be carried up to the junction of the bow and straighter, and made fast at *d*, and thence to *a*; from *a* it must pass through a notch at *e*, up to *c*; then down to *f*, where it must be tied in a notch cut for that purpose, and up to *a* again. Your skeleton being now complete, your next task is to paste a sufficient quantity of



paper together to cover it, and afford a hem to be pasted over the outer edges. Next, bore two holes in the straighter, one about a fifth of the whole length from the top, and the other rather less from the bottom; run through these, and fasten, by a knot at the two ends, your belly-band string, to which the ball of string, by which the kite is flown, is afterward fixed. The wings are made of several sheets of paper, half cut in slips, rolled up fastened at *a* and *c*. The tail, which should be from ten to fifteen times the length of the



kite, is made by tying pieces of paper, four times folded, about an inch and a half broad, and three inches long, at intervals of three inches and a quarter, on a string, with a large bob, similar to the wings, at the bottom of it. Your kite is now complete, and fit to be flown in the usual manner.

It is well known that the celebrated Doctor Franklin once let up a kite previous to his entering the water to bathe, and then, lying on his back, suffered himself to be drawn across a stream by its power.

#### THE WATCH-SPRING GUN.

Neatly cut a bit of wood, about four inches long, into the form of the stock of a pistol or gun; scoop a groove in the upper part of it; in this groove place a large quill, open at both ends, fasten it on with wax thread, and let it project beyond the point of the stock and reach as far as the middle of it; next, procure an old watch-spring, which may be bought cheap at a watchmaker's, cut off a piece of it about as long as the quill, bend it backward, and tie one end of it firmly to the upper part or buttend of the stock. Then bore a small hole through the middle of the stock about an inch from the mouth of the quill; cut a pin in two, fasten one half of it, by its head, to a bit of thread, the other end of which fasten to the thread that binds on the spring; this is the trigger, and your gun is complete. To use it, place a little arrow, or a shot, in the groove between the mouth of the quill and the hole in the stock; put the pin through this hole, and bend back the spring so that the pin may catch it; take the toy in your right hand, pull the trigger out with the fore-finger, and the spring being thus released, will drive the shot, or arrow, through the quill to a considerable distance. If you use arrows you may shoot at a little butt or target.



### SWIMMING.

Swimming has now become an art; and certain rules may be given for its attainment, by the aid of which, and a little practice, the most timid may eventually acquire this necessary art. "In addition to its advantages as a healthy and bracing exercise; humanity alone, the pleasure of being not only able to preserve our own lives, but those of others, ought certainly to be sufficient inducement to acquire a dexterity in this most useful art. The upsetting of the slender boats of the natives of Otaheite is to them a subject of merriment; they swim about, take hold of the light vessel, right her again, and paddle away, never considering they have been in any danger. Were the practice of swimming universal in this country, and it might be so, we should hardly ever read of deaths by drowning." It would be useless to enlarge further upon the advantages to be derived

from acquiring this art; they must be evident to the most inexperienced.

Before we proceed to those rules by which our youthful readers may be enabled to attain proficiency, we conceive that we shall be conferring a benefit on them by offering to their notice some extracts from the excellent advice of the celebrated philosopher, Doctor Franklin, on this subject.

#### DOCTOR FRANKLIN'S ADVICE TO SWIMMERS.

"The only obstacle to improvement in this necessary and life-preserving art is fear; and it is only by overcoming this timidity, that you can expect to become a master of the following acquirements. It is very common for novices in the art of swimming to make use of corks or bladders to assist in keeping the body above water; some have utterly condemned the use of them; however, they may be of service for supporting the body, while one is learning what is called the stroke, or that manner of drawing in and striking out the hands and feet, that is necessary to produce progressive motion. But you will be no swimmer till you can place confidence in the power of the water to support you; I would, therefore, advise the acquiring that confidence in the first place; especially as I have known several, who, by a little practice necessary for that purpose, have insensibly acquired the stroke, taught as if it were by nature. The practice I mean is this: choosing a place where the water deepens gradually, walk coolly into it till it is up to your breast; then turn round your face to the shore, and throw an egg into the water between you and the shore; it will sink to the bottom, and be easily seen there if the water be clear. It must lie in the water so deep that you cannot reach to take it up but by diving for it. To encourage yourself, in order to do this, reflect that your progress will be from deep to shallow water, and that at any time you may by bringing your legs under you, and standing on the bottom, raise your head far above the water; then plunge under it with your eyes open, which must be kept open before go-

ing under, as you cannot open the eyelids for the weight of water above you, throwing yourself toward the egg, and endeavoring, by the action of your hands and feet against the water, to get forward, till within reach of it. In this attempt you will find that the water buoys you up against your inclination; that it is not so easy to sink as you imagine, and that you cannot but by active force get down to the egg. Thus you feel the power of water to support you, and learn to confide in that power, while your endeavors to overcome it, and reach the egg, teach you the manner of acting on the water with your feet and hands, which action is afterwards used in swimming to support your head higher above the water, or to go forward through it.

"I would the more earnestly press you to the trial of this method, because, though I think I shall satisfy you that your body is lighter than water, and that you might float in it a long time with your mouth free for breathing, if you would put yourself into a proper posture, and would be still, and forbear struggling; yet, till you have obtained this experimental confidence in the water, I cannot depend upon your having the necessary presence of mind to recollect the posture and the directions I gave you relating to it. The surprise may put all out of your mind.

"Though the legs, arms, and head of a human body being solid parts, are, specifically, somewhat heavier than fresh water, yet the trunk, particularly the upper part, for its hollowness, is so much lighter than water, as that the whole of the body, taken altogether, is too light to sink wholly under water, but some part will remain above, until the lungs become filled with water, which happens from drawing water to them instead of air, when a person, in the fright, attempts breathing, while the mouth and nostrils are under water.

"The legs and arms are specifically lighter than salt water, and will be supported by it, so that a human body cannot sink in salt water, though the lungs were filled as above, but from the greater specific gravity of the head. Therefore, a

person throwing himself on his back in salt water, and extending his arms, may easily lay so as to keep his mouth and nostrils free for breathing ; and, by a small motion of his hand, may prevent turning, if he should perceive any tendency to it.

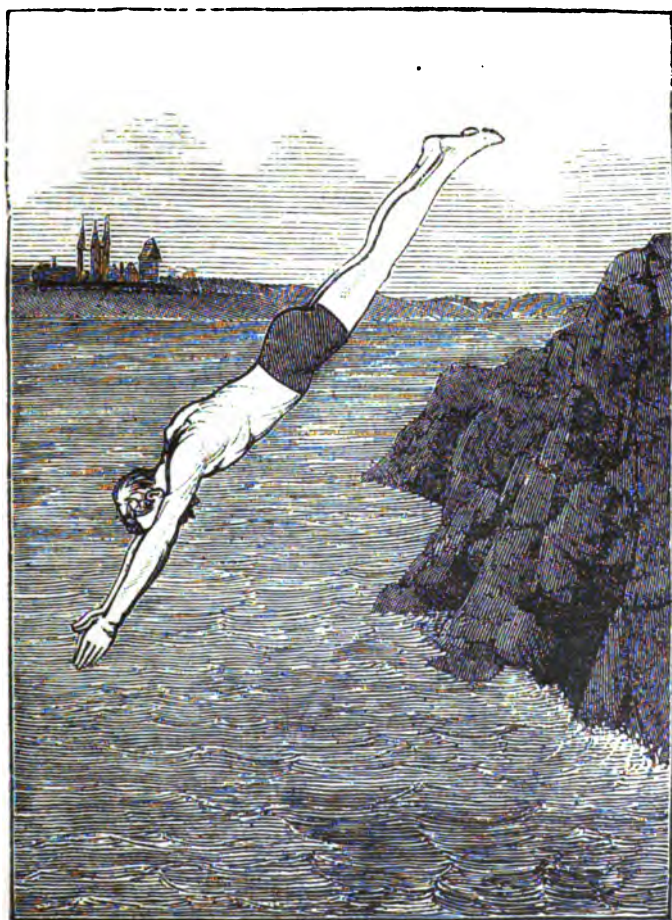
“In fresh water, if a man throw himself on his back, near the surface, he cannot long continue in that situation but by proper action of his hands on the water; if he use no such action, the legs and lower part of the body will gradually sink till he come into an upright position, in which he will continue suspended, the hollow of his breast keeping the head uppermost.

“But if, in this erect position, the head be kept upright above the shoulders, as when we stand on the ground, the immersion will, by the weight of that part of the head that is out of the water, reach above the mouth and nostrils, perhaps a little above the eyes, so that a man cannot long remain suspended in water, with his head in that position.

“The body continuing suspended as before, and upright, if the head be leaned quite back, so that the face look upward, all the back part of the head being under water, and its weight, consequently, in a great measure supported by it, the face will remain above water quite free for breathing, will rise an inch higher every inspiration, and sink as much every expiration, but never so low as that the water may come over the mouth.

“If, therefore, a person unacquainted with swimming, and falling accidentally into the water, could have presence of mind sufficient to avoid struggling and plunging, and to let the body take this natural position, he might continue long safe from drowning, till, perhaps, help should come; for, as to the clothes, their additional weight when immersed is very inconsiderable, the water supporting it; though, when he comes out of the water, he would find them very heavy indeed.

“But, as I said before, I would not advise you, or any





one, to depend on having this presence of mind on such an occasion, but learn fairly to swim, as I wish all men were taught to do in their youth; they would, on many occasions, be the safer for having that skill; and, on many more, the happier, as free from painful apprehensions of danger, to say nothing of the enjoyment in so delightful and wholesome an exercise. Soldiers particularly should, methinks, all be taught to swim; it might be of frequent use, either in surprising an enemy or saving themselves.



### PRACTICAL INSTRUCTIONS.

#### ENTERING THE WATER.

Our young pupil must not, at first, venture into the water in the bold and dashing manner of experienced swimmers. He must wait patiently until he can do so without danger. Let him remember that there has been a time when the best swimmer alive, tottered, step by step, into the water, and sounded the depth with one foot before he lifted the other from the bottom of the stream. We recommend our young friend to be patient, as well as persevering, during his probation in the art of swimming. He must not feel disgusted and disheartened, because he seems to make comparatively but little progress; let him remember that he is gradually acquiring a new and most important power, and is, by



degrees, obtaining a mastery over the waters. It was well observed by a writer of great discernment, that nothing which is worth learning is compassed without some difficulty and application; that it is well worth some pains and trouble to render one's self fearless of falling into a river, in which two out of three of our fellow-countrymen would, in a similar situation, without assistance, be drowned, must be admitted; let not that trouble, therefore, be grudged.

Previously to entering the water, the head and neck should be well wetted; the pupil should then advance, by a clear shelving bank, in some stream, the depth of which he has ascertained by plumbing or otherwise, until he is breast high; then let him face about toward the bank, and prepare to make his first essay in this art, as directed in the next paragraph.

#### STRIKING OUT.

With his face turned toward the bank, as above directed, let the pupil lie down gently on his breast, keep his head and neck upright, his breast advanced, and his back bent



inward. Then, let him withdraw his legs from the bottom, and immediately strike them out, not downward, but behind him; strike out the arms forward, with the palms closed, and

the backs uppermost, a little below the surface of the water; draw them back again, while he is gathering up his legs for a second attempt, and thus push forward, making use of his hands and feet alternately. It will, perhaps, happen, that he will swallow water in his first efforts, but this should not discourage him; neither should he fancy that, because he makes but little advances, he is not as capable of learning to swim as others; the same little mishaps occur to all young beginners.

## CORKS AND BLADDERS.

The use of corks and bladders, for those who are learning to swim, is as strongly recommended by some persons, as it is deprecated by others. That the necessary action with the arms and legs may be acquired more easily with than without them, is clear enough; nevertheless, we are convinced by experience, that it is better to learn how to keep one's self afloat and to be able to swim ten or a dozen yards, at least, no matter how clumsily, without them. We have seen several young persons who, after having attained the necessary action, in a very superior manner, by the use of corks or bladders, were totally unable to keep their heads above the water when they relinquished their aid, and were thus left precisely in the same situation in which they would have been had they not made a single attempt in the art of swimming. We have, it is true, known some trifling exceptions, but they have been rare indeed. Corks and bladders, we think, may be useful, but they should not be commenced with. After the learner has made some progress, and is able to cross a narrow stream, corks and bladders may be occasionally adopted for a short time, in order that the pupil, by means of their support, may, at his ease, perfect himself in the action necessary for superior swimming, especially with the arms and hands. The action of the legs may be much better acquired by means of the plank, as thereafter directed. The best swimmers we have ever met never made use of corks for this purpose, but still they may be considered of advantage in the manner we have stated. If, therefore, our reader should think fit to use corks or bladders, let him attend to the following hints:



Swimming corks are made thus: three or four round slices of cork, increas-

ing progressively in circumference, are run, by a hole made in their centres, on each end of a piece of stout rope, which is long enough to reach across the breast, and beyond the arm-pits; the same number of corks is placed at each side of the rope, and they are kept from slipping off by knots at the two extremities. When bladders are used, they are blown full of air, tied at the necks, and fastened by strings to the ends of the rope, instead of corks.

The manner of using corks or bladders is as follows:—the pupil places his breast across the rope between the corks or bladders as they float; he raises his legs from the ground, and rests his whole weight on the rope, so that the corks or bladders swim between his arms and his sides. In this position he strikes out, and propels himself forward with his legs and feet. The action of the hands and arms supports a swimmer only, so that he would advance almost as much when using corks if he kept them still as if he moved them; nevertheless, their action may be perfected, while the body is supported by the corks, and the young swimmer may acquire that graceful, steady, and powerful manner of striking out, which he may subsequently by degrees bring into practice, when he has thrown the corks aside. This is the manner which we have always followed, and which we recommend our young friends to adopt, of striking out with the arms. The fingers are to be closed, and the thumbs kept close to the hand, which should be straightened, or rather, a little hollowed in the palm; the hands are then to be brought together, the two thumbs touching, or palm to palm, it is little matter which, and raised just under the chin; they are then to be struck vigorously forward, and when the arms are at their full stretch, parted, and carried slowly and regularly, a little below the surface of the water, at the full stretch of the arms, backward, as far as convenience will permit; they should then sink toward the hips; by a slight pressure on the water, as they descend, the body will be raised, the head may be thrown back, and the breath drawn in for the next stroke. When the hands are at, or

near, the hips, they should be raised, with the thumbs or edges, but by no means the backs, upward, to the first position; while doing this, the legs are to be drawn up as near the body as possible, and the soles of the feet struck out against the water with reasonable force, at the same moment the hands are thrust forward again. This is, in fact, the whole principle of swimming:—the arms are first thrust forward, and the body propelled by the force of the soles of the feet, striking against the water; the air in the lungs is expired or breathed forth during this action; the hands are then stretched out and carried round so as to lift the body (which wants no support during the time it is propelled by the legs, and the lungs are nearly full of air), while the legs are drawn up, and the lungs filled with air for a second effort. These very simple motions will seem difficult and complicated to the young swimmer at first, but by degrees he will learn to perform them with facility. Above all things, let him endeavor to do them deliberately and without being flurried. It is a fact, that a swimmer, who is apparently slow in his action, makes more progress by half than one who is quick. The former is deliberate and vigorous; the latter hurried, less effectual, and soon becomes fatigued.

We seriously recommend our young readers never to venture out of their depths with corks, if they cannot swim without them. We once knew a very promising youth who was nearly drowned, when in deep water, by the corks slipping from his breast to below his waist, so that his loins, and at last his legs, were above water, while his head was beneath; he was extricated from his perilous situation by a youth of his own age, who had begun to learn the art of swimming, but without corks, on precisely the same day as the lad who was thus in danger of being drowned. It would be well, if a string were tied by its middle to each end of the rope, close to the largest cork, and one end of it brought over the shoulder at the back, the other in front, and fastened securely together; this would, at least, prevent the corks from getting out of their proper places.

## THE PLANK.

The plank is useful in a bath, to perfect the young swimmer in the manner of properly throwing out his legs and feet. A piece of plank, about ten or twelve feet in length,



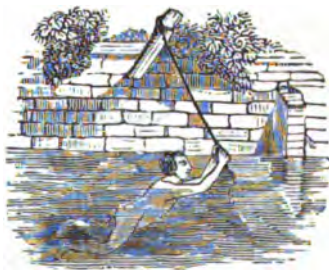
two inches thick, and a foot and a half, or two feet broad, is the best size. It is to be thrown into the water, and the pupil,

after he has acquired the art of supporting himself for a short time, without any artificial aids, should take hold of one of its ends with both hands; his body will thus be supported, and he should strike out with his legs in the manner before directed, and endeavor to drive the plank before him, taking care to hold fast and follow it closely, otherwise he may suffer rather an unpleasant feeling by the plank darting forward, and leaving him to sink, unexpectedly, over head and ears in the water. Of the utility of the plank for the purpose above mentioned, we have frequently been witness and can, therefore, most confidently recommend it to those of our young readers who have an inclination to learn the art of swimming by occasional or preliminary artificial aids.

## THE ROPE, AND OTHER AIDS.

The rope for swimmers is usually fastened to the end of a stout piece of wood, which is fixed into a wall or elsewhere, so as to project over the water; the rope descends to its surface, or it may be long enough for a foot or sixteen inches of its extremity to sink. The use of the rope is to support the learner while practising the action with his legs; but it is very inferior for this purpose to the plank; as, while the pupil keeps himself up, by holding the rope, his body remains in too perpendicular a position, so that he strikes downward rather than backward. The pupil should ac-

custom himself, as much as possible, to keep his legs near the surface; for those who swim with the lower extremities deep in the water never make such rapid way as others who adopt the proper position, which should be within a few degrees of horizontal. The plank has another advantage over the rope; it is more steady in the water, and offers sufficient resistance to induce, and even to assist, the young beginner, as a *point d'appui*, to strike out vigorously with his legs. The rope is, in fact, of more utility to those who go into the water to bathe, than those who are learning to swim; for by means of the support which it affords the bather may raise his legs from the bottom, and exercise himself most beneficially by tossing, stretching, and turning to and fro in the water; he may thus luxuriate in a manner which would be entirely out of his power without the aid of the rope.



The aid of the hand is chiefly applied to very young learners, who have the advantage of bathing with a grown-up swimmer. It is by far superior as an aid, to corks or bladders; because it can be withdrawn gradually, and at last altogether, so that the learner may feel almost insensible of its departure, and restored in an instant, if exertion renders him too weak to support himself. A tall, strong youth, or a grown-up person, takes the little learner in his arms, and goes into the water breast-high with him; he then places the pupil nearly flat upon the water, supporting him by one hand under the breast, and encouraging and directing him to strike out boldly, and, at the same time, correctly. After two or three lessons, on different days, the support of the hand may occasionally be, in some degree, withdrawn; and, in the course of a

week or ten days, the little swimmer will, in all probability, have no further need of its service. Oh! what a happy, triumphant moment is that, when a boy first floats upon the water, independent of all other aids but those which Nature has provided in his own person. He soon becomes exhausted, but, from that time, he feels a confidence in himself, and his progress is generally most rapid.

The aid of the rope and hand we do not so much approve as that of the hand alone. A rope is fastened about the learner's body, a grown person holds the other end of it, and supports the pupil while he acquires the mode of striking out. The aid, in this case, cannot be applied with such precision to the proper part nor afforded and withdrawn with such nicety as where the hand alone is used.

#### SWIMMING OUT OF DEPTH.

We will now suppose our pupil to have made some progress in swimming, and to feel anxious to go into deep water. If he feel quite conscious of his own powers, he may venture a few strokes out of his depth, across a stream, for instance, which is overhead only for a few feet in the centre, with shelving banks on each side. Young swimmers sometimes feel alarmed when they are aware that they have ventured where



they can no longer put their legs on the ground; this feeling flurries them, they strike quick; their hurry increases, trepidation ensues, and they have great difficulty

in returning to the shore. We earnestly caution our pupil against giving way to anything of this sort. Before he ventures out of his depth, let him calculate his own powers, and attempt such a distance only as is in proportion with them. Is he able to swim half a dozen yards without dropping his feet to the ground? If so, he

may confidently cross a deep place which is only half that breadth. Let him not imagine that he is not quite as capable of swimming in deep as in shallow water; the contrary is the fact, for the deeper the water the better he can swim. Above all things, let him not hurry himself, but strike slowly and evenly, and keep good time with the motions of his arms, his legs, and his lungs. Boys frequently fall into an error, which is invariably attended with unpleasant consequences, when first attempting to swim, as well as when they begin to venture out of depth, by losing their presence of mind and breathing at the wrong time. They draw breath at the moment when they are striking out with their legs, instead of at the time their body is elevated by the hands, when at the full stretch of the arm backward, or in descending toward the hips. During this action of the legs, the head partially sinks, the face is driven against the water, and the mouth thus becomes filled, which creates a very unpleasant nausea and momentary suffocation. When the hands are in the position above mentioned, the progress of the body forward ceases, the face is no longer driven against the water, but is elevated above the surface; then is the time to draw in the breath, which should be expired while the body at the next stroke is sent forward by the action of the legs. During this time, if your mouth be even with or partially under the surface, no water can enter it, the air which you are driving between your lips effectually preventing it. "Keep time," is one of the swimmer's golden rules. Unless the pupil pay attention to it, he will make but little progress, and must inevitably, now and then, take in a mouthful of the stream in which he is swimming. To those who have never swam "in the silver flood," a circumstance of this sort will be thought very lightly of indeed; but we speak the general feelings of swimmers, when we say, that the same person who would relish a draught from a stream when sitting dressed upon its bank, would feel the greatest disgust at taking a mouthful of the same water when swimming in it.



After the pupil has ventured out of his depth, and feels satisfied with the success of his attempt, he grows emboldened, and increases his distances daily.

#### TO TREAD WATER.

All that is necessary for treading water, is to let your legs drop in the water until you are upright; then keep yourself afloat in that position by treading downward with your feet, alternately, and if necessary paddling with your palms at your hips.

#### TO SWIM ON THE SIDE.

Lower your left side, and at the same time elevate your right; strike forward with your left hand, and sideways with your right; the back of the latter being in front instead of upward, the thumb side of the hand downward, so as to serve precisely as an oar. You will thus, by giving your body an additional impetus, advance much more speedily than in the common way; it will also relieve you considerably when you feel tired of striking out forward. You may also turn on the right side, strike out with the right hand, and use the left as an oar. In either case, the action of the legs is the same as usual.

#### TO SWIM LIKE A DOG.

Strike with each hand and foot alternately; that is, begin with the right hand and foot, draw the hand toward the chin, and the foot toward the body at the same time; and then simultaneously kick backward with the foot and strike out in a right line with the hand; then do the like with the left hand and foot, and so on. The hands are not to be carried backward as in the ordinary way of swimming, but merely thrust out with palms downward, a little way below the surface, in front only; as they are brought back to the breast again, they should be rather hollowed, and the water grasped or pulled toward the swimmer. Much progress cannot be made by swimming in this manner, but still

it is worth learning, as every change of method in going a distance, recruits the swimmer's strength.

#### THE PORPOISE.

This is a very pleasant and most advantageous change of action. The right arm is lifted entirely out of the water, the shoulder thrust forward, and the swimmer, while striking out with his legs, reaches forward with his hand, as far as possible. At the utmost stretch of the arm the hand falls, a little hollowed, into the water, which it grasps or pulls toward the swimmer in its return to the body, in a transverse direction, toward the other armpit. While it is passing through the water in this manner, the legs are drawn up for another effort, and the left arm and shoulder elevated and thrust forward as above directed for the right. This is the greatest advancing relief in swimming, except swimming on the back; floating on the back rests the whole of the body as well as the limbs, but while floating no progress is made; whereas, during the time a person swims in the manner above directed, he will not only relieve himself considerably, but also make as great an advance in the water as if he were proceeding in the ordinary way.

#### TO SWIM AND FLOAT ON THE BACK.

To do this you must turn yourself on your back as gently as possible, elevate your breast above the surface, put your head back, so that your eyes, nose, mouth and chin only are above water. By keeping in this position with the legs and arms extended, and paddling the hands gently by the side of the hips, you will float. If you wish to swim, you must strike out with the legs, taking care not to lift your knees too high, nor sink your hips



and sides too low; but keeping in as straight a line as possible. You may lay the arms across the breast; keep them motionless at the side; or, if you wish, strike out with them to help you on.

To swim with your feet forward, while on your back, lift up your legs one after another, let them fall into the water, and draw them back with all the force you can, toward your hams; thus you will swim feet forward, and return to the place whence you came.

To turn from your breast to your back, raise your legs forward, and throw your head backward, until your body is in a right position; to change from the back to the breast, drop your legs, and throw your body forward on your breast.

#### TO TURN WHEN SWIMMING.

If you wish to turn while on your back, keep one leg still, and embrace the water beside you with the other; thus, you will find yourself turn to that side on which your leg by its motion embraces the water, and you will turn either to the right or left, according to which leg you use in this manner.

To turn while swimming in the ordinary way requires no further effort than to incline your head and body to the side you would turn to, and at the same time move and turn your legs in the same manner as you would do to turn the same way on land.

#### TO SHOW THE FEET.

While on your back, bend the small of it downward; support yourself by moving your hands to and fro just above your breast, and stretch your feet above the water.

#### THE CRAMP.

Our practical directions in the art of swimming would be incomplete were we to omit saying a few words as to the cramp. Those who are at all liable to it, ought, perhaps, to abandon all idea of swimming; men of the greatest skill as

swimmers, and of presence of mind in danger, having fallen victims to this, which has been well enough called "the bathers' bane." The cramp may, however, seize a person for the first time in his life, when at a distance from land; we have frequently known this to occur; and in every case that has come within our personal knowledge, with one exception, the sufferer has saved himself by acting as we are about to advise our young reader, if ever he should be seized with this terrible contraction. Be assured that there is no danger, if you are only a tolerable swimmer, and do not flurry yourself. The moment you feel the cramp in your leg or foot, strike out the limb with all your strength, thrusting the heel out, and drawing the toes upward as forcibly as possible, totally regardless of the momentary pain it may occasion. If two or three efforts of this nature do not succeed, throw yourself on your back, and endeavor to keep yourself afloat with your hands until assistance reach you; or, if there be no hope of that, try to paddle ashore with your palms. Should you be unable to float on your back, put yourself in the position directed for treading water, and you may keep your head above the surface by merely striking the water downward with your hands at your hips, without any assistance from your legs. In case you have the cramp in both legs, you may also endeavor to make some progress in this manner, should no help be at hand. If you have one leg only attacked, you may drive yourself forward with the other. In order to endow you with confidence in a moment of danger from an attack of the cramp, occasionally try to swim with one leg, or a leg and a hand, or the two



hands only, and you will find that it is by no means difficult.

We feel rather astonished that none of the treatises on swimming, which have fallen into our hands, recommend the practice of boys attempting to carry one another in the water; when both can swim this is an excellent and safe method of learning how to support another who is in danger on account of cramp, weakness, ignorance of swimming, or other causes. In the annexed sketch, the foremost figure is in the act of swimming, and carrying with him another person, who is borne up, simply by applying one hand to each hip of his companion. A person, it is said, had the pleasure of saving a friend from drowning, by these means: it is attended, however, with considerable risk, especially if the person you venture to rescue should lose his presence of mind, which is too often the case with those who are in danger of being drowned. It will surprise any swimmer, who first tries the experiment, to find with what ease he can support a person attached to him in this manner. The person who rests upon the hips of his companion, is represented as passive, as he is supposed to be unable to swim; but two swimmers, performing this experiment, may strike out together with their legs.

#### PLACES FOR SWIMMING.

Of all places to swim in, the sea is best, running waters next, and ponds the worst.

#### DIVING.

Diving, by practice, may be carried to astonishing perfection. Pearls are brought up from the bottom of the sea by divers who are trained to remain a considerable time under water. In ancient times, divers were employed in war to destroy the ships of the enemy; and many instances are related, by respectable authors, of men diving after, and fetching up nails and pieces of money thrown into the sea, and even overtaking the nail or coin before it has reached the bottom.

Diving may be performed from the surface of the water when swimming, by merely turning the head downward,



and striking upward with the legs. It is, however, much better, to leap in, with the hands closed above the head, and head foremost, from a pier, boat or raised

bank. By merely striking with the feet, and keeping his head toward the bottom, the diver may drive himself a considerable distance beneath the surface. If he reach the bottom, he has only to turn his head upward, spring from the ground with his feet, and he will soon arrive at the surface. If desirous of making a more rapid ascent, he should strike downward with his feet, pulling the water above him toward his head with one hand, and striking it downward by his side with the other. In diving, the eyes should be open; you must, therefore, take care that you do not close them as they reach the surface, when you commence your descent. It is almost needless to add, that the breath should be held, the whole time that you are under water.

#### SWIMMING UNDER WATER.

Swimming between top and bottom may be accomplished by the ordinary stroke, if you take care to keep your head a little downward, and strike a little higher with your feet than when swimming on the surface; or, you may turn your thumbs downward, and perform the stroke with the hands in that position, instead of keeping them flat.

#### TO BEAT THE WATER, ETC.

When swimming on your back, lift your legs out of the water one after another, and strike the water with them alternately. Those who are most expert at this bring their chins toward their breasts at each stroke of the legs.

There is a variety of similar feats performed by expert swimmers, such as treading water with both hands raised over the head; floating on the back with the arms above the surface; taking the left leg in the right hand out of the water, when swimming on the back; pulling the right heel by the right hand, toward the back, when swimming in the common way; throwing somersets in the water, backward and forward, etc., etc., for which no particular directions are necessary, as the pupil, when he has grown expert in the various modes of swimming which we have described, will be able to do these things, and any tricks which his fancy may suggest, without difficulty.

#### CONCLUDING REMARKS.

If one of your companions be in danger of drowning, be sure that, in endeavoring to save him, you make your approaches in such a manner, as will prevent him from grappling with you; if he once get a hold of your limbs, you both will almost inevitably be lost.

Although it has been said that the weight of one's clothes will make but little difference in the water, yet we strongly advise the young swimmer, when he has become expert in the art, and confident of his own prowess, to swim occasionally with his clothes on; for this purpose, of course he need only use an old worn-out suit: by so doing, he will be satisfied that dress does not make so much difference as he might imagine, and thus he will have more courage and presence of mind if he should at any time afterward fall into the water, or leap in to save another.

"This is the purest exercise of health,  
The kind refresher of the summer heats."

—THOMSON.



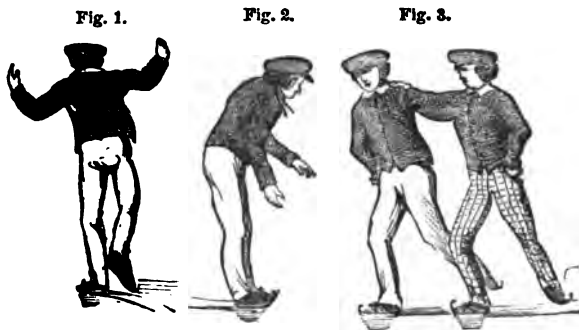
### SKATING.

"O'er the ice as o'er pleasure, you lightly should glide,  
Both have gulfs, which their flattering surfaces hide."

Skating is by no means a modern pastime, and probably the invention proceeded rather from necessity than the desire for amusement. It was the boast of a northern chieftain, that he could traverse the snow upon skates of wood. Some traces of skating are found in the thirteenth century, at which period it was customary in the winter, when the ice would bear them, for the young citizens of London to fasten the leg bones of animals under the soles of their feet, by tying them to their ankles, and then taking a pole shod with iron into their hands, they pushed themselves forward by striking it against the ice, and moved with celerity, equal,



says an old author, "to a bird flying through the air, or an arrow from a cross-bow;" but some allowance, we presume, must be made for the poetical figure.



#### HOW TO START OFF. AND TO STOP.

When your skates are fixed, rise up, stand on your heels, and stamp them on the ice to fix the foot firmly; then strike out, at first slowly, with the right foot, leaning on the inside edge of the skate, and bending slightly forward. When you have slid about two yards on that foot, put the other on the ice, and gently throw your weight upon it, striking out in the same manner upon the inside edge, and so on with each foot alternately. Fig. 1 represents the attitude of a learner at first starting off. When you wish to stop, raise the toes from the ice, and rest on your heels as in Fig. 2. Bend the body forward gradually, and do not attempt to lean backward, the certain consequence of which would be a severe fall. A stick is used by some beginners to steady themselves, but we do not advise it. It is better, at first, to have the support of a companion who can skate (Fig. 3), and by degrees he may leave you to your own exertions; above all things, do not be disheartened by a few falls.

## THE SKATE.

Skates are made fluted or plain. For young beginners the former are preferable, as regards safety; but with the latter only can velocity and elegance of movement be acquired. A quarter of an inch in thickness, and about three-quarters of an inch in height, are proportionate dimensions for the blades of skates. High bladed skates are dangerous for beginners, and require considerable exertion of the muscles to keep the ankle stiff, while the nearer the feet are brought to the ice, without risking their contact, the less will be that strain, and the greater the facility of moving in all directions. The blades should be slightly curved at the bottom, as this form assists the skater in turning either heel or toe outwards or inwards with rapidity. Previously to going on the ice, the learner should practise, both walking about with his skates on, and balancing himself on either foot. The club skate, in which there is no wood, is preferred by some to all others.

## HOW TO PERFORM THE VARIOUS EVOLUTIONS.

Before the skater attempts to cut figures and other devices, he must be able to skate on the outside edge of the skate, to skate backwards, and to turn round. The "outside edge" implies what it is by its name; when acquired, it sends you exactly in opposite directions, on both sides, to what the "inside edge" does. In explanation:—Suppose that you are skating on the right foot, it is easy to turn to the left, but not so to the right, to effect which you must use the outside edge, by striking out upon it either foot, inclining at the same time the skate, the leg, the body, and the head, toward whichever side you are skating, holding the other foot raised up behind, and rounding the arms.

The right hand should be raised towards the head in skating on the left outside edge, and the left hand when skating on the right outside edge. The most difficult forward movement is the cross outside edge which is done by passing one

leg across the other, and striking out with the foot as it comes down on the ice. As the foot on which you first rested disengages itself (which it will do as you proceed) from the crossed-leg position, throw that leg over the other, and, by continuing this, you will soon learn to sweep round on either side with ease. This is called the Mercury Figure.

The salute in a right line is not easy of execution. Having first struck out, you must place the feet in a horizontal line, elevating and rounding the arms. Continue the movement as long as you can, or think fit to do so. This attitude, though difficult, is frequently practised by good skaters.

The salute in a curved line is much easier. Having started, you put your feet in the position you would adopt to describe the salute in a right line, only less horizontally. The head and body must be upright, the arms rounded, the hands placed on the haunches; in this position you describe a circle. You then draw yourself up, the knees having become slightly bent, and, raising the right or left foot, prepare for another evolution; as either striking out straight forward, or toward one side.

To describe circles and curves will be found the most graceful and useful of evolutions. To describe a curve on the outside edge forwards, fix on some point as a centre, and take a run proportioned to the number of curves you propose describing. Strike out on the outward edge, turning in a curve round the centre fixed upon. Your eyes must look towards the shoulder opposite that which directs the general movement of the side on which you turn; your arms must be extended; the one directing the movement should be raised above the head, and the other held downwards, in the direction of the leg describing the curve. The hips must be kept in, and the leg on which you are propelled bent slightly at the knee-joint. The opposite leg must also be bent, and thrown backwards, to modify by its weight and position the impulse forward, and to insure your equilibrium.

To describe a curve or circle on the inside edge forwards, you must select a small piece of cork, or any other light



body, as a centre, take a sufficient run, and strike out on the inward edge. Your head and body must be in the position described for outward curves, only the leg on which you skate must not be bent. The opposite leg should be almost stiff, and the foot about 18 inches from the one you rest upon. Curves on the inside edge are terminated by stopping in the usual manner; but if you desire to pirouette or turn round, you throw the foot on which you do not skate over that on which you do, and from the impulse given to your body in order to describe the curve, you spin round on the middle of the skate as on a pivot. After having done this a few times, you bring down the foot you are not revolving on, and proceed to other evolutions.

To skate backwards, you must incline the head and body slightly forward, in order not to lose the centre of gravity. Strike out behind on each foot alternately, and raise the heel of the skate slightly up from the ice. By this operation each foot will describe an arc or segment of a circle. Should you feel to be losing your equilibrium, bring both skates together on the ice.

This evolution is performed sometimes on one foot, sometimes on the other, and occasionally on both together, by the help of a slight motion of the hips.

Retrograde or backward curves differ from ordinary curves by their direction only: and at first sight appear difficult, because a person cannot move backwards with the same facility that he can go forward. When, however, you are used to this manner of skating, it will appear natural and tolerably easy of execution. The backward curve is of equal importance with the ordinary curve on the outside edge, and constitutes the base of all retrograde or backward figures. In this evolution the position of the arms and head is not the same as for the ordinary curve on the outside edge. When executing the outward retrograde curve, your face must be turned towards the left shoulder, and the right hand raised towards the head. The reverse takes place for the movement to the left, and the inverse generally when the motion is forward instead of backward.

The oblique stop is the most proper to adopt when you are skating backwards. In order to perform it, when engaged in a retrograde movement, you bring down on the ice in an oblique and transverse position the skate on which you are not resting, stiffening at the same time the leg you thus bring down. The effect of this manœuvre is prompt and certain, and the only variation it admits of is, that it can be performed on either foot. To turn round, bring either heel behind the other, and you turn as a matter of course.

By carefully attending to the above directions, with practice, you will be able to cut the numerical figures, or any device that you may wish. The figure 8 is the best practice, and is described by completing the circle on the outside edge forward. See cut on previous page. This is performed by crossing the legs, and striking from the outside instead of the inside edge. To cross the legs, the skater, as he draws to the close of the stroke on his right leg, must throw the left quite across it, which will cause him to press hard on the outside of the right skate, from which he must

immediately strike, throwing back the left arm, and looking simultaneously over the left shoulder, so as to bring him well upon the outside edge of the left skate. The 8 is formed by completing a perfect circle, in the manner described, on each leg, before changing the foot. The figure 8, which is performed on the inside edge backwards, may next be practised.

#### CONCLUDING OBSERVATIONS.

The young skater should avoid both very rough and very smooth ice. He must be fearless, but not too violent in his motions, and should never be in a hurry. He must avoid looking downwards to see how his feet act, and should recover his balance between each stroke. For safety his body may be bent slightly forward during his first essays, but when he has acquired sufficient confidence, he should bear himself erect, carry his head well up, and always turn his face in the direction of the line he proposes describing.

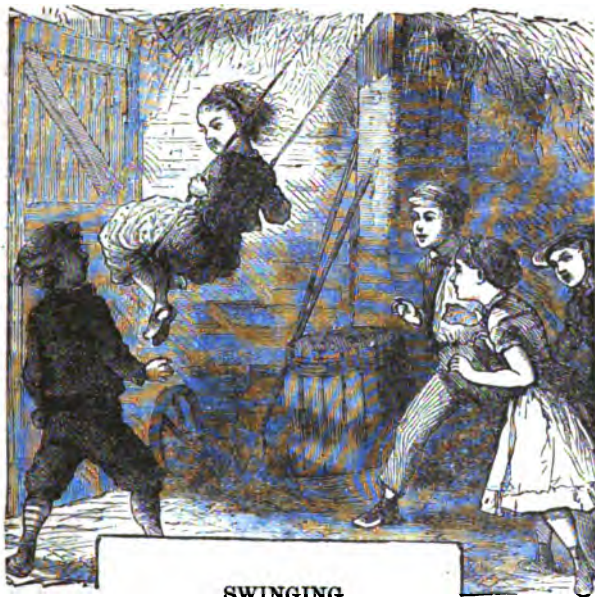
He should wear flannel next his chest to absorb the perspiration caused by the exercise, and avoid skating against the wind, if of a delicate constitution. When unexpected danger arises, he should strive to be perfectly collected. If surrounded by rotten ice he must crawl on his hands and knees, that the support of his weight may be distributed. If he fall upon rotten ice at full length, he must roll away from it toward firmer ice; and should he be so unlucky as to get into a hole, he must extend both arms outward in opposite directions upon the surface of the ice, and tread water until assistance come. A plank or ladder offers the best means of extrication, either being easily pushed along the ice; or a rope may be thrown to a person immersed; but we hope our young readers, by prudence and caution, will avoid the necessity of their application.

## HIDE AND SEEK.

This is very like the preceding game; a handkerchief, or some other trifle, is concealed by one player, and the rest attempt to find it; the discoverer takes the next turn to hide the article. It is a custom, in this game, for the boy who has hid the article to encourage those who approach it, by telling them that they burn, and to warn them of their departure from it by saying they freeze.

## DUCK ON A ROCK.

Duck should be played by a number exceeding three, but not more than six or eight. A large stone with a smooth top is placed on or fixed into the ground, and an offing marked at eight or ten yards distance. Each of the players being previously provided with a large pebble, or stone, double the size of a cricket ball, or thereabout, one of them, by chance or choice, becomes duck; that is, he places the pebble or stone with which he is going to play, on the large stone, and stands a little on one side. The others then cast their pebbles or ducks at it, in turn, from the offing, each endeavoring to knock it off its place. Each player, as soon as he has cast his duck, watches for an opportunity of carrying it back to the offing, so as to cast again. If the player who is duck, can touch him after he has taken up his pebble, and before he reaches the offing, provided his own pebble remain on the large stone, then the player so touched becomes duck. It sometimes happens that three or four of the out-players' ducks lie so close together, that the player who is duck can stand in a situation to be within reach of all of them; in this case, they cannot, without running the risk of being touched, pick up, until one of those who are at the offing is lucky enough to strike the duck off the large stone; then before its owner can replace it, which he must do before he can touch a player, they all take up their ducks and run to the offing, where, of course, they are safe.



SWINGING.

The construction of the swing is simple: two ropes of equal lengths are to be suspended from any branch or cross-piece of timber, of adequate strength; at the bottom of these ropes a seat is to be securely fastened, and the party who takes the seat must be propelled by another on the ground: a rope for this purpose must be fastened to the back part of the seat.

#### TUG OF WAR.

This game is played by two parties, whose numbers are equal; they all take hold of a rope, and the object of each party is to pull those belonging to the other across a chalk



line on the ground, by means of a rope. When all the players on one side are thus pulled over or made prisoners, the other party wins the game. This is a very lively sport, any number may join in it, and it affords capital exercise and much amusement.

#### TIP-CAT.

Tip-cat, or, perhaps, more properly, the game of cat, is a well known pastime. Its denomination is derived from a piece of wood, called a cat, with which it is played; the cat is about six inches in length, and an inch and a half or two inches in diameter, and diminished from the middle to both the ends, in the shape of a double cone; when the cat is laid upon the ground, the player, with his stick, strikes it smartly, it matters not at which end, and it will rise with a rotary motion, high enough for him to beat it away as it falls, in the same manner as he would a ball.

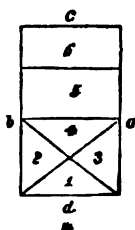
There are various methods of playing the game of cat, but we shall only notice the two that follow. The first is exceedingly simple, and consists in making a large ring upon the ground, in the middle of which the striker takes his station; his business is to beat the cat over the ring. If he fails in so doing he is out, and another player takes his place: if he be successful, he judges with his eye the distance the cat is driven from the centre of the ring, and calls for a number, at pleasure, to be scored toward his game; if the number demanded be found, upon measurement, to exceed the same number of lengths of the stick, he is out; on the contrary, if he do not, he obtains his call. The second method is to make four, six, or eight holes in the ground, in a circular direction, and as nearly as possible at equal distances from each other, and at every hole is placed a player with his stick; one of the opposite party, who stand in the field, tosses the cat to the batsman who is nearest him, and every time the cat is struck, the players are obliged to change their situations, and run once from one hole to another in succession; if the cat be driven to any great distance, they

continue to run in the same order, and claim a score toward their game, every time they quit one hole and run to another; but if the cat be stopped by their opponents, and thrown across between any two of the holes before the player who has quitted one of them can reach the other, he is out.

### HOP-SCOTCH.

It is played with an oyster-shell, in the following manner:

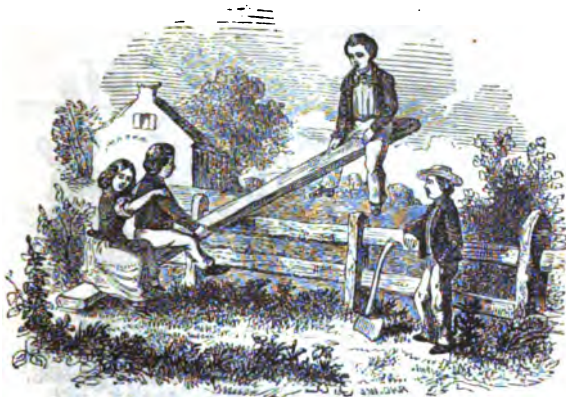
—Draw, with chalk, on the ground, a figure similar to the cut in the margin. Toss up for innings. He who wins stands at the \* and throws the shell into No. 1, which is called the first bed; he then steps with his right foot into that bed, and “scuffles,” that is, jerks, with his right foot, the shell out toward the \*. He now throws the shell into No. 2, steps with his left foot into No. 1, and then, placing his right foot in No. 2, scuffles the shell out as before, and steps with one foot back to No. 1, and thence out. He must now throw the shell into No. 3, and step into 1, 2, and 3, scuffle the shell out, and step back through the beds alternately. He must then go to 4, 5, and 6, in succession, and at each throw, step into every previous bed with one foot only, and the like when coming back, reversing the numbers. After this, the player puts the shell into No. 1, hops into that bed, scuffles the shell into 2, and so on to 6, and back again in the same manner, bed by bed, to the \*. Lastly, he places the shell into No. 1, puts his right foot in the bed, and scuffles the shell through all the beds, beyond the further line of 6, at one jerk. If the player who gets the innings do all this correctly, he wins the game. If, however, he put himself out, as hereafter described, the second player takes the innings; if the latter put himself out, without going through the game, the first takes up his own game, where it was when he went out; the second also does the like with his, if the first gets out a second time. When



there are more than one innings, the first who goes through the game, as above stated, wins. A player loses his innings in either of the following cases:—If he throw the shell into the wrong bed, or on the line, or put two feet into one bed, or a foot upon the lines, or does not scuffle the shell out of the bed in which it lies at the first attempt, or put his hands to the ground, or throws or scuffles the shell beyond line *c*, (except in the last, or what is called “the long scuffle,”) or outside the lines *a b*; or if, in going forward, he put his leg into 3 before 2, or the contrary when coming back; or if, when scuffling the shell through on the hop, he drive it beyond the next bed in which it lies; or if, in any part of the game, when he has stepped into a bed, he take more than one hop in order to get near the shell; or if he hop after he has scuffled it; or, last, if, in the long scuffle, he do not, at one effort, send it with his foot from beyond the line of *c*. But observe, that when he has cast the shell into No. 2, or any bed beyond it, he is not compelled to scuffle it out, that is, beyond the line *d*, at one effort.

#### THREAD THE NEEDLE.

Thread the needle may be played by a considerable number of boys, who all join hands, and the game commences with the following dialogue between the two outside players at each end of the line: “How many miles to Babylon?” “Threescore and ten.” “Can I get there by candlelight?” “Yes, and back again.” “Then open the gates without more ado, and let the king and his men pass through.” In obedience to this mandate, the player who stands at the opposite end of the line and the one next him, lift their joined hands as high as possible; the other outside player then approaches, runs under the hands thus elevated, and the whole line follows him, if possible, without disuniting. This is threading the needle. The same dialogue is repeated, the respondent now becoming the inquirer, and running between the two players at the other end, with the whole line after him. The first then has his turn again.



### SEE-SAW.

A plank is placed across a felled tree, or low wall, or anything similar, and a player seats himself at each end; by a slight exertion, if the plank be properly balanced, each end rises and sinks alternately. It must be observed that, if the players be of unequal weight, he who is the heavier must, to preserve the due equilibrium, make his end of the plank shorter.

### WHOO.

This game is played as follows:—All the players but one, collect at a place called "home," while one goes off to hide himself. When ready, he shouts "Whoop oh!"—the others then sally out to find him; he who discovers the hidden player, calls out "Whoop oh!" The hidden player then breaks from his concealment, and if he can catch one of the others, the one so caught must carry him on his back to "home." It is then the boy's turn who has made the discovery to go and hide himself, and the others endeavor to discover his lurking place, as before.



### *GAMES IN THE SNOW.*

#### COASTING.

Where is the boy who has not enjoyed a good sport coasting or sleigh-riding as above. You have only to get a good sleigh and a hill covered with snow, and start from the top, when away you go rushing along—faster, and still faster, till you almost lose your breath, before you reach the bottom; then jump up and pull your sleigh to the top and repeat your journey till you are tired. If you want to be weatherwise during a snow storm, look to the west; if the sky is red and the wind is in the north, you are safe for a coasting trip next day.

#### THE SNOW GIANT.

This is made by rolling a snow ball until it gets too large to be moved, you then cut away the sides and place a smaller one on the top for a head, carve out his nose and legs and place two pieces of coal or stones for his eyes. You can then make a number of snow balls and pelt him from a distance, trying to break his nose and fill up his eyes.

## HUNT THE SLIPPER.

This is usually an in-door game, although there is no other objection to its being played on a dry piece of turf than that the slipper cannot be heard when struck by its momentary possessor, when passing round the joyous ring. Several young persons sit on the ground in a circle, a slipper is given to them, and one, who generally volunteers to accept the office in order to begin the game, stands in the center, and whose business it is to "chase the slipper by its sound." The parties who are seated, pass it round so as to prevent, if possible, its being found in the possession of any individual. In order that the player in the center may know where the slipper is, it is occasionally tapped on the ground, and then suddenly handed on to the right or left. When the slipper is found in the possession of any one in the circle, by the player who is hunting it, the party on whom it is so found, takes the latter player's place.

## HOP, STEP, AND JUMP.

This is a sport of emulation ; the object is to ascertain which of the players concerned can eventually go over the greatest portion of ground in a hop, a step, and a jump, performed in succession, and which may be taken either standing or with a run, as may be agreed, at the outset, between the players.

## DRAWING THE OVEN.

Several players seat themselves on the ground, in a line, and in such a manner that each may be clasped round the body by the player who is seated behind him. When all are thus united, two others take the one who is at the extremity of the line by the two hands and pull until they separate him from the grasp of the one who is behind him. They then take the second in the same manner, and so on until they have thus drawn the whole line.

### THE LAME LAMPLIGHTERS.

Two boys kneel, each on one knee only, holding the other leg off the ground, one opposite the other, a lighted candle is given to one, and another candle, not lighted to the other ; they then attempt to illumine the latter ; but being in equilibrium on one knee, and liable to be thrown off their balance by the least motion, they will find this so difficult a matter as to cause great diversion to the spectators.

### THE JUMPING ROPE.

A long rope is swung round by a player at each end of it ; when it moves tolerably regular, one, two, or even more boys, step in between those who hold the rope, suffering it to pass over their heads as it rises, and leaping up so that it goes under their feet when it touches the ground, precisely as is the case of a common skipping-rope. The principal difficulty in this sport is, to run between the players at the proper moment of time, that is, just as the rope is at its highest elevation, so as to be ready to jump over when it comes toward the feet. Care must be taken that due time be kept in the leaps, so that they may perfectly accord with the motion of the rope.

There is another mode of playing with the long skipping-rope, namely, by the player at one end of it, advancing a step or two toward the other, keeping the hand which holds the rope on the outside, and then, with the assistance of the player at the other end, turning the rope round, and skipping over it in its circuit.

### DROPPING THE 'KERCHIEF.

A number of players join hands so as to make a circle ; one only stands out ; he walks round the outside of the circle, and drops a handkerchief behind which player in the circle he thinks fit. The party behind whom the handkerchief is thus dropped immediately follows the one who dropped it ; those who stood on each side complete the circle by

joining hands, and the chase commences. The pursuer is bound to follow precisely the course of the pursued, who winds in and out under the arms of the other players, who elevate them for his accommodation, and endeavors, by all means in his power, to puzzle and elude him. If he succeed in so doing, that is, if the pursuer make a blunder in his course, he returns to his place in the circle, and the first player prepares to drop the handkerchief behind one of the players again. When he is fairly overtaken by the player behind whom he has last dropped the handkerchief, the latter takes his place, and he joins hands in the circle.

#### BUCK.

This is a miniature resemblance of "Saddle my Nag;" but it neither requires speed, nor even agility. It is a sport for two boys only, who should be nearly equal in size and strength. A third, who does not join in the game, stands by as umpire. The game commences by one of the players giving a back; that is, placing his arms across his breast, or resting them on his knees, stooping forward so as to bring his back nearly horizontal with his head, which he supports against a post, wall, tree or whatever may be convenient for the purpose. It is usual, but we think quite unnecessary, for the player who gives the back to be blindfolded; we say unnecessary, because the only object for doing this is to prevent him seeing what is going on behind, or, rather, above his back, which he cannot possibly do, if he keep his head in a fair and proper position; and the umpire should see that he does so. The first player having thus taken his position, the second leaps, or vaults, astride on his back, holds up as many of the fingers of one hand as he pleases, and says, "Buck, buck, how many horns do I hold up?" The player who gives the back makes a guess; if he name the right number the other player becomes Buck, and gives him a back. If, however, his guess be an incorrect one, the rider gets off, vaults on again, holds up the same or a different

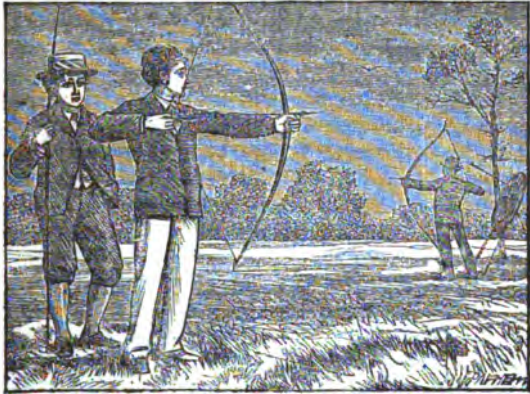


number of fingers, and asks the same question as before; this is repeated until the Buck name the true number. It is the business of the umpire to see that there is no foul play on the part of the rider. We should suggest that it would be an improvement on this quiet, simple game, for the umpire to be made a third player; so that when the Buck's guess is correct, the rider should give a back, the umpire become rider, and the Buck umpire: thus, instead of the place of umpire being a mere idle vocation, the game would be productive of amusement and exercise to all three of the boys engaged in it.

#### BLIND-MAN'S BUFF.

This popular, old-fashioned, and delightful pastime, is so well known, as to render any description of it unnecessary. There is, however, a variation of it called Shadow Buff, which is less known, but equally amusing. A large piece of white linen is suspended smoothly at one end of a room; at a little distance from it, Buffy, with his face toward the linen, is seated on a low stool. Directly in a line, and about a yard behind him, a table is placed with a candle on it; all the other lights must be extinguished. The players then walk one by one, between the table and Buffy (who must not turn his head), limping, hopping, and grimacing as they please, so as to distort their shadows on the linen. If Buffy can tell correctly to whom any shadow belongs (guessing once only for each person), the player, whom he so discovers, takes his place.





## ARCHERY.

### THE BOW.

The young archer should, in the first place, select a bow that is fit and proper for his own size and strength. It is not probable that, let him be ever so skilful, he will be able to achieve such an exploit as the construction of a good bow himself, bow-making being a trade which requires many years' practice and much attention.

The back of the bow is the flat outside, and the belly the round inside part of it. The round inside part is bent inward; if the bow be pulled the reverse way it will break; therefore, however a bow may be bent when unstrung, it is invariably to be strung with the round part inward.

### ARROWS.

Arrows should be delicately proportioned in length and weight to the bow for which they are intended. They are used blunt or sharp, and varying in their thickness according to the fancy of the archer. Some are made so as to taper gradually from the feathers to the pile, and some

*vice versa*; others again are thickest in the centre. All arrows should have their nocks or notches cased with horn, and the nocks should be of such a size as to fit the string with exactness, and be neither too tight nor too loose. Three goose or turkey feathers are affixed to arrows; one of these, denominated the cock feather, is of a different color from the other two, and this is always to be placed uppermost.

### THE STRING.

That part of the string which receives the nock of the arrow is whipped with sewing silk, to prevent the string being rubbed and weakened. If the silk should come off the string, it ought to be re-whipped without delay; otherwise it will be in danger of breaking; and this is not the only mischief, for from the breaking of a string oftentimes ensues the snapping of the bow. It is also advisable to whip the noose and eye of the string, although many archers do not trouble themselves to do so. At one end of the bow-string an eye is made; it is left for the archer himself, bows being of different lengths, to make the other; this, to a young archer, will be found rather difficult; his best plan will be to inspect the mode of making the noose on an old string. The young archer will do well, if any of the threads of his string break, to throw it by and use another. He should never, if possible, permit the string to become twisted or raveled; should such an occurrence take place, before it is put on again it ought to be re-twisted and waxed. A bow, five feet long when braced, should never have the string more than five inches from its centre. This rule will be a guide to the young archer in stringing his bow; whatever be its length he will of course adjust the distance in the same proportion, according to the measurement.

### THE TASSEL.

This is very necessary to the archer for the purpose of cleaning the arrow from such dirt as generally adheres to it

if it enter the ground. This dirt, if suffered to remain, will impede the arrow in its flight, and also render its course untrue. The tassel is suspended on the left side of the archer, and is thus always at hand for use.

#### THE GLOVE.

The glove consists of places for three fingers, a back thong and a wrist-strap to fasten it. The finger-stalls should neither project far over the tops nor be drawn back to cover the first joint. The glove is used for the purpose of protecting the fingers from being hurt by the string.

#### THE BRACE.

The brace is worn on the bow arm to save it from being injured by the string, which, without this protection, would, in all probability, incapacitate the archer from shooting long at a time. It is made of stout leather with a very smooth surface, so that the string may glide over it without impediment.

#### THE QUIVER.

The quiver is for the reception of the arrows, but is never constantly worn except in roving; it is now usually made of tin, although it is occasionally constructed, as was indeed universally the case formerly, of wood or leather.

#### THE BELT, POUCH, AND GREASE-BOX.

The belt is buckled round the waist; the grease-box is suspended from the middle, and the pouch or bucket on the right side of it. A composition for greasing the finger of the shooting-glove, and the smooth side of the brace, when occasion may require, is kept in the box; the pouch holds the arrows for immediate use in target shooting.

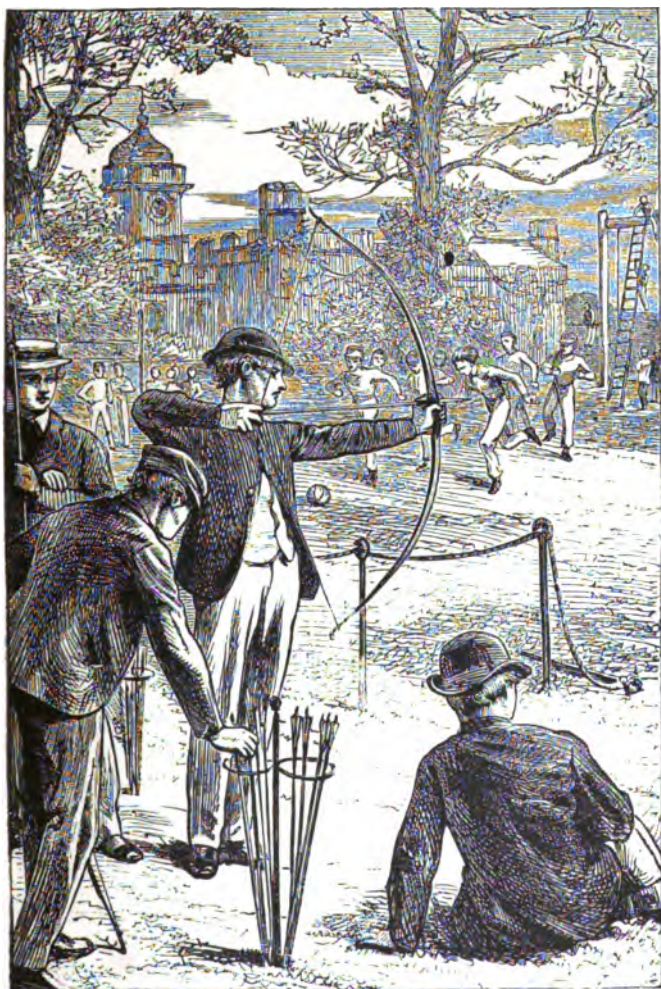
#### BUTTS.

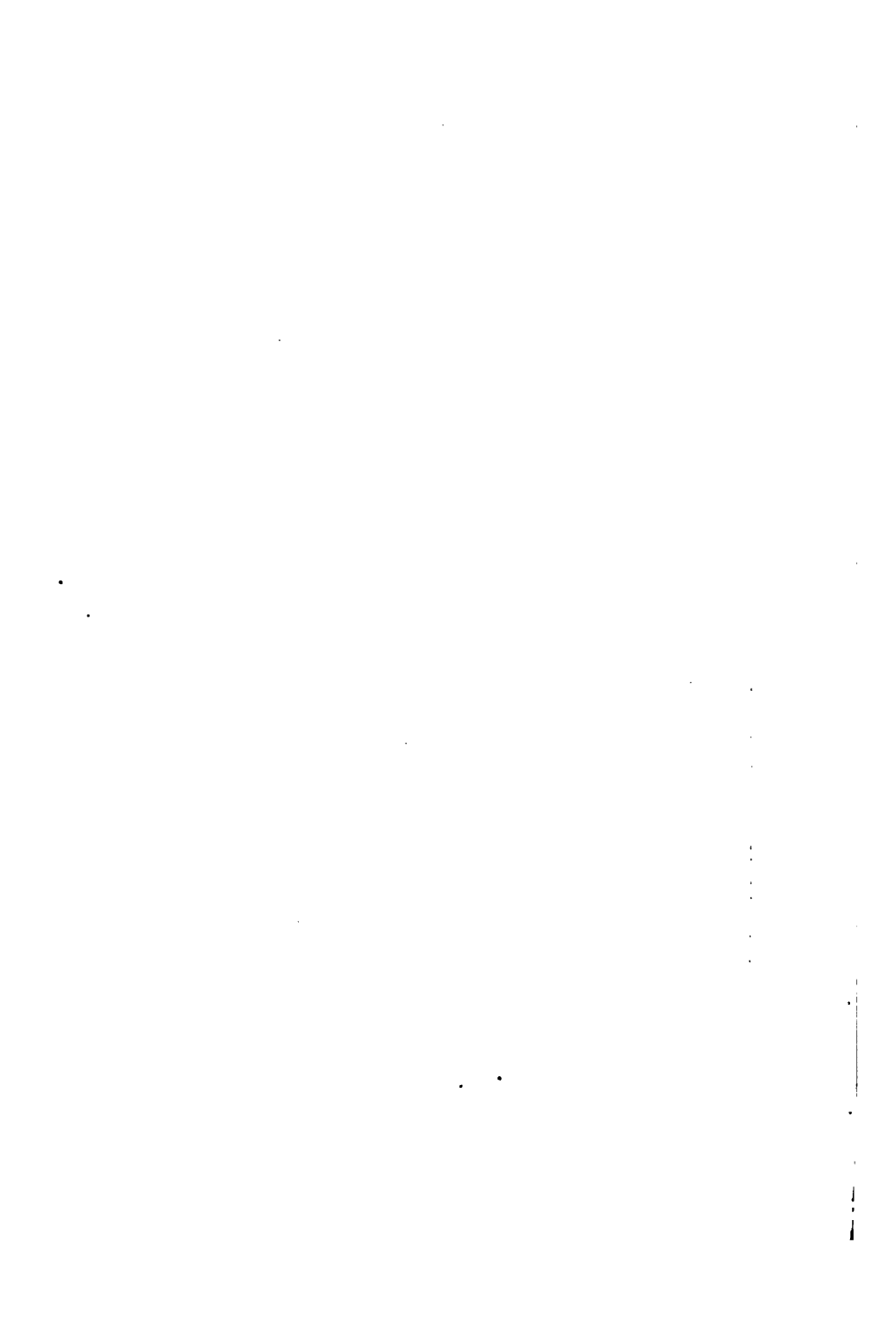
The butt is rather pyramidical in shape, generally speaking, but it may be fashioned according to the fancy of the archer; for grown-up persons, they are seven or eight feet wide,

three or four feet thick at the base, and nearly seven feet in height at the middle. Butts are made of long plats of turf which are to be closely pressed down; a round piece of pasteboard is placed in the centre of the butt for a mark, which must be increased or decreased in size according to the distance at which the archer shoots: for thirty yards it should be four inches in diameter; for sixty yards, six inches; and so in proportion for a greater distance. The mark is fixed to the butt by a peg driven through its centre. Shots that take place outside the mark are not reckoned, and he who places most shots in the pasteboard during the play is accounted the winner. Butts are frequently placed at different distances from each other; a set of butts is four, which are so contrived as not to prevent the players seeing them all at once. What is called a single end is shooting at one mark only; a double end is shooting to a mark, and back again from that mark to the one first shot from.

#### TARGETS.

Targets should be proportioned to the size and skill of the juvenile archer, and to the distance at which he stands from them. The facing is usually made of canvas which is sewn on the bass; the bass is made of straw, worked as a bee-hive. The facing has a gold centre and four circles; namely, the outer white edged with green, the black inner, white and red. Where it is not convenient to keep the targets fixed, it is better to use another kind, made of pasteboard, these being more portable, although by no means so durable, as targets made of the other materials we have mentioned. If one target only be shot at, a great deal of time is wasted in going to fetch the arrows, and again returning to the spot for shooting from; two targets are therefore generally used, and the archers shoot from one to the other. In archery matches there are generally two prizes; one for the greatest number of arrows shot into the target,—the other for the shot nearest the gold centre. Hits in the target are sometimes reckoned all alike; but there is usually a dis-





tion made. The gold centre is the mark, and the circle which approaches nearest to it, being less in size, and consequently more difficult to hit, and nearer the main mark itself, an arrow shot in that circle is deemed of more value, in reckoning for the prize, than if it were to take place in any of those outside it, and so in proportion with the others. A celebrated society of archery allows the following numbers for each circle. For the gold, nine; for the red, seven; for the inner white, five; for the black, three; and for the outer white, one. A writer on this subject, however, seems to think that the outer circles are overrated, and if nine be allowed for the centre, only three should be scored for the red; two for the inner white; and less in proportion for the two outer circles. When the sport terminates, the value of the number of hits, and not the hits themselves, should be reckoned; and he whose score is the largest, is, of course, the victor.

As ink is by no means a convenient thing to carry into the field, and marks made with the black-lead pencil are liable to be rubbed out, it is advisable to have a pin suspended from a card, properly divided for each archer's score, and to prick down the hits with it.

#### STRINGING THE BOW.

— The bow is to be taken in the right hand, by the handle, with the flat part toward the person who is about to string it, his right arm should rest against his side; the lower end of the bow, which has always the shortest bone, should be placed against the inside of the right foot, which should be turned a little inward to prevent the bow from slipping; the left foot should at the same time be brought forward; the centre of the left-hand wrist must be placed on the upper limb of the bow below the eye of the string, the forefinger knuckle upon one edge of the bow, and the top of the thumb on the other. The bow is now to be pulled up vigorously, and the upper limb of it pressed down by the right hand, and the wrist of the left which it should at the same



time slide upward until the eye of the bowstring is safely placed in the nock. The middle, the ring, and the little fingers should all three be stretched out, as they are not wanted in this operation of stringing the bow; moreover, if this be not done, they are liable to be caught between the string and the bow, and thus become severely punished. The young archer should take care that the eye is well placed in the nock before he removes his left hand. He should not become impatient in the action of stringing the bow, but perform it systematically as directed; if he do not succeed, let him lay it by for a few minutes, and when he is cool make a second attempt. To unstring the bow, the short horn is to be placed on the ground; the palm of the left hand receiving the flat side of the upper limb; the string should be upward; the handle is then to be pressed with the right arm so as to slacken the string; when the latter becomes loose enough, the eye is to be brought out of the nock by the thumb of the left hand.

#### POSITION.

The face is to be turned toward the mark, but no part of the body, which, if the mark be north, should be turned to-



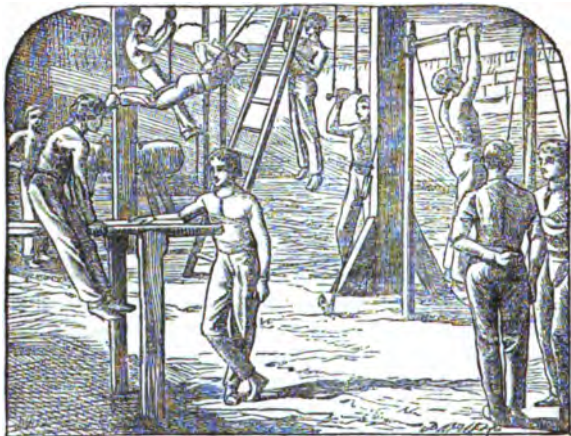
ward the east; the head should be rather inclined; the left hand, with the bow in it in a perpendicular position, is to be held out straight toward the mark; the arrow is to be brought well toward the ear, and not the eye, on the left side of the bow and under the string; the forefinger of the left hand passes over it; by the other hand the nock is placed in the string at the proper place, with the cock feather uppermost; when this is done, the forefinger of the

left hand is removed and placed round the bow. While the left hand is raising the bow, the right should be drawing the string with two or three fingers only, and not the thumb; as soon as it reaches the head it should be let loose, for fear of its breaking.

Great care should be taken to acquire a proper position, as represented in the marginal cut, for bad attitudes in archery appear extremely ridiculous.

#### CONCLUDING REMARKS.

We strongly recommend the young archer never to shoot with another person's bow; he may, very probably, break it; and in that case, a loss might ensue to the owner, which money could not remedy. When the grass is above the ankle, shoot only at a considerable elevation. After two or three arrows are shot, the archer should cease awhile, otherwise his aim will get unsteady. If he shoot point-blank at a mark, the arrow, if it miss, will strike along, and so bury itself in the grass as to defy the keenest eye, in many instances, for a very considerable time, to discover it. This inconvenience may be remedied by shooting at a proper elevation, for then the arrow will descend in such a manner as to leave the feathers visible; they will also be saved from that injury which frequently occurs to them by the moisture of the grass or ground, when shot point-blank. Arrows should not be used of different lengths, nor should the young archer shoot alone; for in solitary shooting, he falls into habits of negligence and indifference; if he practice with others, he will strive to emulate his companions; and, instead of a careless, unskilful marksman, soon become an adept in the pleasant pastime of ARCHERY.



### *GYMNASTIC EXERCISES.*

The necessary fittings-up of a gymnastic ground are as follows :—An horizontal bar, a vaulting-horse, a leaping-stand, parallel bars, a climbing-stand, and ladders of rope and wood.

The best time for performing gymnastics is early in the morning. Boys should proceed gradually from the more easy to the more difficult exercises; and it is most advisable to practise these sports under the eye of an experienced person. Where there is a number of boys, they should be divided into classes, according to their strength. It is advisable to carry no toys in the pockets when practising; extra clothes should be put on when the exercises are finished; and the usual precautions adopted to prevent taking cold.

The following observations, which are principally from Salzmann, may be perused with advantage. No person in health is injured by being overheated; but drinking when extremely hot, or being cooled too quickly, in whatever manner it happens, may prove highly pernicious. It is proper,

therefore, to take off whatever clothing can be decently spared, before beginning to exercise, and put it on again immediately after. Lying down upon the cold ground, too, must not be allowed. On commencing any exercise, begin, not with its more violent degrees, but with the more gentle, and leave off in the same manner; sudden transitions are always dangerous. Never let bodily exertion, or your attempts to harden the frame, be carried to excess: let your object be to strengthen the feeble body, not to exhaust and render it languid. In all exercises, attention should be paid to such a position of all the parts of the body, that none may be exposed to injury; for example, the tongue must never be suffered to remain between the teeth. The left hand and arm are commonly weaker than the right; let them be frequently exercised, therefore, by lifting, carrying, and supporting the weight of the body by suspension, till they become as strong as the others.

Although walking, running, dancing, balancing, vaulting, climbing, jumping, wrestling, riding, swimming, and all other muscular exercises, may be included in the term *Gymnastics*, the common course adopted at the schools includes only walking, running, jumping, vaulting, balancing, and climbing.

#### RUNNING.

In running, the legs should not be raised too high; the arms should be nearly still, so that no unnecessary opposition be given to the air by useless motions. Running in a circle is excellent exercise, but the direction should be occasionally changed, so that both sides may be equally worked.

#### THE DEEP LEAP.

This is performed from a flight of steps, increasing the depth according to the progress of the pupil. The body should be bent forward, the feet close together, and the hands ready to touch the ground at the same time with or rather before the feet. We do not, however, much approve of this exercise.

### WALKING.

In walking, the arms should move freely by the side, the head be kept up, the stomach in, the shoulders back, the feet parallel with the ground, and the body resting neither on the toe nor heel, but on the ball of the foot. On starting, the pupil should rise one foot, keep the knee and instep straight, the toe bent downward. When this foot reaches the ground, the same should be repeated with the other. This should be practised until the pupil walks firmly and gracefully.

### JUMPING.

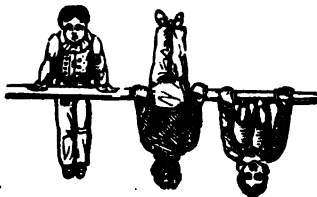
The first rule in jumping is, to fall on the toes and never on the heels. Bend the knees, that the calves of the legs may touch the thighs. Swing the arms forward when taking a spring, break the fall with the hands, if necessary; hold the breath, keep the body forward, come to the ground with both feet together, and in taking the run, let your steps be short, and increase in quickness as you approach the leap. Begin with a moderate height or breadth, and increase both as you improve.

### PARALLEL BARS.

Begin by raising the body by the hands, and then moving the hands alternately backward and forward, until you go along the bars each way by means only of your hands. Then move or jump with both hands at once. The swing is performed by supporting the body by the arms, with the stomach upward, until the toes are in a straight line with the head; when the pupil can do this with ease, he should throw his body from this position over the bar to the right or left. The movement of lowering the body by bending the elbows is done by drawing up the feet towards the hams, and sinking gradually until the elbows are even with the head; rise again by straightening the arms, and repeat the exercise several times. Many other exercises may be performed on these bars, which will occur to the pupil in the course of his practice.

### . HORIZONTAL BAR.

The first position is taking hold of the bar with both hands, and raising the body until the chin is on a line with the knuckles. When you can look over the bar in this manner with ease, place the hands on the further side of the bar from you, and raise the body as before. In the next exercise, the body is raised from the ground by both hands on each side of the bar, and the pupil passes, springs, or moves the hands alternately along the bar. Keep the legs close, lift the feet so as to touch the bar and sink them down again; repeat this several times, and when in this position, pass along the bar by alternately moving the hands; the body may then be supported by the right arm and left leg, and afterward by the left arm and right leg; you may then place yourself in a riding position on the bar. You may also swing with the head downward; take the bar with both hands, and pass the feet between them, until they hang downward; you may either return them the same way, or drop upon your toes to the ground.



### THE LONG LEAP.

Make a trench, which widens gradually from one end to the other, so that the breadth of the leap may be increased daily. Keep the feet close together, and take your spring from the toes of one foot, which should be quickly drawn up to the other, and they should descend at the same instant; throw the arms and body forward, especially in descending. Take a run of about twenty paces.

### PROSTRATE AND PERPENDICULAR.

Hold your arms on your breast, lie on your back and get up again, without making use of either your elbows or hands.

### THE HIGH LEAP WITH THE POLE.

Take the pole with the right hand about the height of the head, and with the left about the height of the hips; when put to the ground, spring with the right foot, and pass by the left of the pole, over whatever you have to clear, turning round as you alight, so as to front the place you leap from.

### VAULTING.

The horse for vaulting is made of a wooden cylinder with rounded ends; two ridges are placed across it, the space between which is called the saddle, and should be wide enough apart for a person to sit between them with ease. The horse may be wadded or not, according to fancy. Leaping on the horse is performed by springing by the hands astride upon it. The body is raised in the same manner, until the feet reach high enough to stand on the horse; the hands are then to be placed on the further ridge, and the body thrown forward into the saddle.

Vaulting into the saddle may be performed with or without a run; place the hands on one of the ridges, take a spring, and turn the body on one side, so that one leg may pass over the horse, and the performer descend astride into the saddle. To vault sideways over the horse, the hands must be placed as above, and a spring made sufficient to throw the feet over the horse; one hand then leaves its hold, and you descend on the other side. To vault on or over the saddle forward, take hold of each ridge with the hands, and spring between them, so as to rest or to go over the saddle.

### TO CLIMB THE ROPE.

In climbing the rope the hands are to be moved alternately, one above the other, the feet drawn up between every movement of the hands, and the rope grasped firmly between them; in descending, move one hand after the other, as the friction, if you slide, would blister them. The best method to climb the slant rope is to lay the sole of one foot flat on the rope, and the other leg over the instep of that foot.

### THE HIGH LEAP.

Get a stand made of two upright posts, bored through with holes, through which you may pass a string at what length you please, with sand bags of sufficient weight to keep it straight, and yet not so heavy as to prevent your carrying it away with your foot, in case you touch it while leaping; or you may have holes bored to admit movable pegs to support the string, as in the cut. You must take this leap both standing and with a run; for the former, the legs should be kept together, and the feet and knees raised in a straight direction; for the latter, we recommend a short run, and a light tripping step, gradually quickened as the leaper approaches the string. You should be particularly careful not to alight on your heels, but rather on the toes and balls of the feet.



### THE DEEP LEAP WITH THE POLE.

This requires strength in the arms and hands. Place the pole the depth you have to leap, lower the body forward, cast off your feet and swing round the pole so as to alight with your face fronting the point you leaped from. Come to the ground, if possible, on the balls of your feet.

### THE TRIUMPH.

Place the palms of the hands together, behind you, with the fingers downward, and the thumbs nearest the back; then, still keeping as much as possible of the palms together, and at least the fingers of one hand touching those of the other, turn the hands, by keeping the tops of the fingers close to the back, until the ends are between the shoulders, with the palms together, the thumbs outward, and the tops of the fingers toward the head. This is a very difficult feat, and well deserves its title.



### ASCENDING THE LADDER.

Take hold of each side of the ladder, and ascend by moving the hands alternately. To climb the ladder by runnels, the learner must bring the elbow of the arm which happens to be the lowest, down to the ribs, before he pulls himself up by the other. To climb the ladder by one side, take hold of one side of the ladder with both hands, the palms toward the outer part of the side; move the hands alternately, and keep the legs close and steady.

### TO CLIMB THE PERPENDICULAR OR SLANT POLE.

Move the legs and hands alternately, taking care, however, not to place the hands over each other, as in climbing the rope. In descending the pole, the hands are held ready to be used, if necessary, on each side of it; the legs being then a little slackened, you will descend with great ease.

### STEPPING THROUGH YOUR OWN FINGERS.

Get a bit of wood, or half of a tobacco-pipe, hold it between the two forefingers of each hand, and, without letting it go, after a little practice, you may leap over it, forward and backward without difficulty; when perfect in this, you may, as the writer of this has frequently done, place the tops of the two middle fingers together, and leap over them both ways, without either separating or touching them with the feet. It is impossible to perform this trick with high-heeled shoes; and, in fact, the great difficulty consists in clearing the heels.

### THE FLYING BOOK.

Place a book, or other convenient thing, between the two feet, in such a way that it is held between the ankles and the inner side of the feet; then kick up backwards with both feet and throw the book over your head.

## THE PLANK.

The breadth of the plank should be about two feet; its thickness, two inches; to climb it, the hands are to be placed on each side, and the feet on its surface; ascend by moving them alternately. Elevate the plank by degrees as you improve in the exercise. The progress that may be made in the ascension of the plank is astonishing. We know several gymnasts who can ascend a plank in a perpendicular position, without difficulty. To do this, the body and feet are in a different position to that represented in the marginal cut, where the figure is merely travelling up an inclined plane; to ascend a perpendicular plank the body is curved inward more from the shoulders downward, and the legs thrust up so that the higher one is nearly even with the hand.



## DOT AND CARRY TWO.

The person who is to perform this exploit (whom we shall designate as No. 1), stands between two others (whom we shall call Nos. 2 and 3); he then stoops down and passes his right hand behind the left thigh of No. 2, whose hand he grasps; and his left hand behind the right thigh of No. 3, whose left hand he grasps. Nos. 2 and 3 then pass each one arm round the neck and shoulders of No. 1, and when in this position, No. 1, by raising himself gradually from his stooping position, lifts the others from the ground.

## KNUCKLE DOWN.

An exercise of some difficulty, is performed by putting the toes against a chalk line, kneeling down and rising up again, without any assistance of the hands or moving the toes from the chalk line.



#### LIFTING AT ARM'S LENGTH.

Elevating a pole at arm's length has long been accounted a superior feat ; to do this, the arm must be stretched out at full length, the pole (the poker will do to begin with) grasped with the nails upward, and elevated in a right line with the arm.

#### CHAIRING THE LEG.

Place the left foot on the lower back rail of a chair, then pass your right leg over the back of the chair, and bring it to the floor between the chair and your left leg. This is to be done without touching the chair with your hand.

In doing this trick, the chair should not stand upon a slippery floor, as it may move from under you, and cause a fall; a heavy chair should also be selected, and great care taken while performing it.

#### THE FINGER-FEAT.

Your arms must be horizontally placed across the breast, and close to it; the fore-fingers of each hand must then be brought into contact. In this position another person must endeavor to separate your fingers by pulling at each arm. However much stronger he may be than you, he will not be able to detach your fingers, if you hold them properly. It must be agreed, previously, that the person who attempts to separate the fingers of the other shall not use a sudden jerk, but a regular force.



### FLYING STEPS.

This is a very beneficial exercise. Fix a beam firmly in the ground, with a strong iron cap, that moves in a circular horizontal position, at the top of it; four ropes are to be fixed to the cap, and bars of wood fastened at the bottom of the ropes, which are to be taken hold of, and the pupils vault round, bearing the weight on the rope, and continually increasing in speed until they touch the ground only at intervals with their toes.

### THE LONG REACH.

A line is to be marked on the floor, to which both feet, or rather, the toes of both your feet are to be brought, and beyond which they must not pass. One hand, either right or left, at option, is then to be thrown forward (without touching the floor in its passage) so far and no farther than you can spring back again from the horizontal position to the original upright position of the body, without disturbing the stated posture of the feet, or scraping the floor with the hand in the back-spring. The distance at which different persons can thus spring back from the hand, will, of course, differ according to their length of arm, or their strength and activity.

When you have ascertained the distance at which you can recover without scraping the hand or changing the original position of your feet, you must stretch forward as far as possible; and whilst your body is supported by the hand on the floor, chalk as far as possible with the other; after this, rise up from your hand and recover your original position, without touching the ground again with either hand. There is great scope for skill and activity in this feat, and there are persons not exceeding five feet, or five feet and a few inches, who will chalk considerably farther than others six feet high. The great art is, to bring your body as near to the floor as possible; for which purpose, it is recommended (and allowable) to move the feet backward from the line of demarkation as far as you can, which will bring the body much lower, and enable you to chalk, at least, the full length of yourself, which is considered pretty good chalking, although there are persons who will exceed the distance very considerably. Those who perform this trick the best, contrive, when on the stretch, that the body may rest upon the elbow.

#### TWO TO ONE.

With the skipping-rope several excellent exercises may be performed; the best, perhaps, is the following. Skip in the common way for a few seconds, constantly increasing your velocity of movement, and, at length, leap tolerably high, and whirl the rope round so fast that it may pass twice under your feet before they touch the ground; continue this until you can repeat it several times in succession, and, at last, pass the rope three times, instead of twice, under your feet during the leap.

#### TUMBLE-DOWN DICK.

This feat must be performed with a long-backed chair; place the knees on the extremity of the feet of the chair, and, with your two hands, take hold about the seat rail; bring your face down to touch the back of the chair, upon

which, at the extremity, or as near as you can come without falling forward, or suffering the top of the chair to touch the floor, a piece of money, or &c., is placed, which is to be removed with the mouth. Much of the management in this trick depends upon properly regulating the position of the hands, which may be shifted as you find necessary, up or down the upright pieces which form the back of the chair. A strong, old-fashioned kitchen-chair is the best for this purpose.

### THE STOOPING STRETCH.

This feat, in which considerable agility may be acquired by practice, is performed in the following manner: Draw a line on the floor, against which place the outer edge of the right foot; at a moderate distance behind the right heel, place the left heel against the line. Take a piece of chalk in the right hand, stoop a little forward, pass the right hand between the legs immediately under the right knee, and chalk the floor as far beyond the line as you can, so that you can recover yourself without moving the toes of the feet, or touching the ground with either of your hands. In this case there is no spring from the hand, as the chalk only, which is held between the two fore-fingers, touches the floor. Your knee and body may project over the chalk line, if your feet keep their proper place, as above directed, on the outer side of it.



### THE GREAT WOODEN BALL.

Casting the wooden ball is a very good recreation. A large wooden bowler, in which several holes are bored, is used for this purpose. Place your thumb in one of these holes, and your middle, or fore-finger, in another, and cast it, under-handed, either at a mark or for a distance. The

common bowl used in skittle-alloys (we do not mean those used for nine-pins) will afford a pattern ; the maker must, however, remember that its dimensions are to be decreased, it being too heavy, and the finger-holes too far apart for the use of boys. It ought to be adapted in size to the age of those persons for whose use it is intended.

### THE TURN-OVER.

In performing this feat, it is necessary to take a run of half-a-dozen paces. The trick is to place the toe of the right



foot against the wall, about the height of the knee from the ground, and to throw the left leg over it, making an entire revolution, so that when your left leg reaches the ground, your back will be to the wall. The toe of the right foot is the point upon which you must turn ; and it must not quit the wall during the performance of the exploit. To perform the turn-over appears to be a matter of

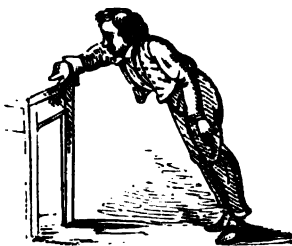
considerable difficulty, at the first glance of the description ; but it may be attempted by a lad of tolerable activity, who has made himself master of the instructions, without danger, and in a short time accomplished with facility. Ordinary care must, of course, be taken during the early attempts.

### THE TANTALUS TRICK.

An amusing scene may be produced by requesting a person to stand with his back close against the wall, and, when in this position, placing a piece of money on the ground a short distance before him, and offering it to him if he can pick it up without moving his heels from the wall. This, he will find, is impossible, as on stooping forward, a part of the body goes back beyond the heels, which, in this case, the wall will, of course, prevent.

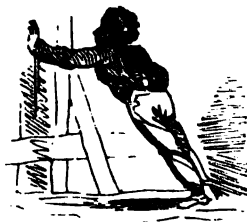
## TRIAL OF THE THUMB.

This feat is very simple. Place the inside of the thumb against the edge of a table, and then move your feet backward as far as you can from the table, so as to be able to recover your upright position by the spring of your thumb without moving your feet. You may accomplish this feat with much greater ease, if, previously to springing from the thumb, you make two or three bends to and fro with your body. Neither the fingers, nor any part of the hand, except the thumb, should touch the table. It is advisable to begin by making the spring with your feet at a short distance only from the table at first, and to draw them further from it gradually as you improve in the performance of the feat. The table from which you spring ought to be a heavy one, or the opposite end of it placed close against a wall, otherwise you may push it back when making your spring; in which case, a fall on the hands and knees would be almost inevitable.



## THE PALM-SPRING.

A feat, which affords excellent exercise, something similar to the thumb-trick, is performed by standing with your face toward a wall and throwing yourself forward, until you support yourself from falling, by the palm of one of the hands being placed, with the fingers upward, against the wall; when in this position, you must recover your former erect station by springing from your hand, without bringing your feet for-





ward. According to the greater or less distance you stand from the wall, the more or less difficult the feat will be. As in the feat of the Trial of the Thumb, it is better to begin the performance of the Palm-spring at a short distance only from the wall, at first; by practice, if you are active and resolute, you may, at last, rise with ease with your feet placed full two-thirds of your own height distant from the wall.

### LEAP BEFORE YOU LOOK.

Much care must be taken in this, as well as in "The Tumble-down Dick" feat, lest you hurt yourself. Procure a chair that is strong, and at the same time so narrow in the back that you can bestride it with ease; stand on the seat, push with your hands against the top rail, and your knees against the middle one, until you get it tilted on its back legs; but before you lose your footing, leap from the seat, so as to alight on the ground, still holding the top rail in your hand, and the back of the chair between your legs. We repeat that great caution is necessary at first, but after a little practice, the feat is very easy. Without confidence in your own powers, it can never be performed; to give you this necessary confidence, be assured that hundreds have succeeded in achieving it.

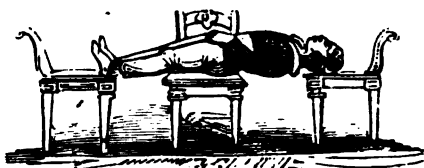


### THE PULLEY.

Fasten a common pulley to a horizontal piece of wood, or the branch of a tree; run a cord through it, with a cross piece of wood at each end; two boys take hold of these cross pieces,—one lies on his back, and the other pulls him up, sinking himself as he raises his companion; he in turn, is elevated in the same manner, and thus each sinks and is raised alternately.

### TO TAKE A CHAIR FROM UNDER YOU WITHOUT FALLING.

The figure represents a youth with the back part of his head resting on one stout chair, and his heels upon another, and a third chair, which ought to be of rather a lighter make, is placed under him. He must stiffen his body and limbs, throw up the chest, keep the shoulders



down, and disengage the middle chair, which he must carry round over his body until he deposits it again under him on the opposite side. This is another of those feats which seem very difficult, but which are, in fact, easy of execution. Be assured that if you do not succeed in it, provided the middle chair be not too heavy for your strength, it is because you have not sufficiently attended to the instructions.

### BREAST TO MOUTH.

Many persons find much difficulty in performing this feat. Measure the distance between the outside of the elbow and the extremity of the longest finger; mark that distance on a walking-stick or ruler, as shown by Fig. 2. This stick must be held horizontally before you, as in the annexed sketch, Fig. 1; the middle finger being placed exactly over the mark; the fingers must be kept at right angles with the stick, and the thumb placed over them, as shown by the fist grasping the stick (Fig. 2.)



Holding the stick in this position you must, without changing the place of your fingers, lowering your head, or removing your elbow from your side, endeavor to raise the left end of the stick from your breast to your mouth.

#### THE POKER PUZZLE.

This feat is to be performed with a common fire-poker, which you must hold near the top, between the fingers and thumb. You must then, by the mere motion of the fingers and thumb, work or screw the poker upward, until the slender part is moved up to the hand, whilst the poker remains perpendicular during the whole process. For the first few times that this is attempted to be done, considerable difficulty will be met with, as it not only requires strength in the fingers, proportionate to the weight of the poker, but also a certain knack, which is only to be acquired by practice. We have seen some persons perform the poker puzzle, apparently without the least exertion, while others of equal strength have tried their utmost, and failed in the execution of it at last.

#### THE CATCH-PENNY.

This is a trick with which many of our young friends are doubtless well acquainted ; there are others of them who never heard of it, and we therefore give a sufficiently minute description of the manner of doing it, for the benefit of those who are in the latter case.

Place two, three, or even four penny pieces in a heap on your elbow ; drop your elbow suddenly, and bring your hand to a little below where your elbow was, and you may catch them all. It is impossible, however, to accomplish this, unless you bring your hand exactly beneath the bend of your elbow, and perform the motion with quickness.

#### STILTS.

Walking on stilts is practised by the shepherds of the Landes, or desert in the South of France. The habit is

acquired early, and the smaller the boy is, the longer it is necessary to have his stilts. By means of these odd additions to the natural leg, the feet are kept out of the water, which lies deep during winter on the sands, and from the heated sand during summer; in addition to which, the sphere of vision over so perfect a flat is materially increased by the elevation, and the shepherd can see his sheep much further on stilts than he could from the ground. Stilts are easily constructed: two poles are procured, and at some distance from their ends, a loop of leather or rope is securely fastened; in these the feet are placed, the poles are kept in a proper position by the hands, and put forward by the action of the legs. A superior mode of making stilts is by substituting a piece of wood, flat on the upper surface, for the leather loop; the foot rests on and is fastened by a strap to it; a piece of leather or rope is also nailed to the stilt, and passed round the leg just below the knee; stilts made in this manner do not reach to the hands, but are managed entirely by the feet and legs. In many parts of England, boys and youth frequently amuse themselves by

WALKING ON STILTS.



*FENCING.*

Wouldst have thy son acquire a graceful port,  
A manly bearing ;—make his eye acute  
As that of the hawk, and his young limbs vie  
With those of roe-bucks in agility ?—  
The noble art of Fencing let him learn.

In those days when a small sword was an indispensable ornament to the person of a gentleman, objections were sometimes raised to the cultivation of the art of Fencing, as tending to lead young persons into broils and duels ; but nothing can now be said against it on this score ; the wearing of swords, except among military men, has long ceased, and duels being invariably decided in this country by pistols. The art of Fencing is acquired, therefore, as the means of affording excellent exercise, elegant amusement, and imparting an easy deportment and graceful action, as well as extraordinary acuteness of eye, and agility of body. That it has these merits, there can be no doubt ; and it is, therefore, confidently recommended to youth, as being not only perfectly unexceptionable, but even superior in most respects to all other exercises.

*FOILS, MASKS, ETC.*

The foils should be proportioned to the size of those who use them. Thirty-one inches is the medium for men ; it is advisable to use a glove on the right hand, padded on the back and the outside of the fingers ; the masks must have wire fronts stout enough to resist an accidental thrust at the face. An easy dress should be worn, and it is usual, in academies, to have a spot, or heart, on the left side of the breast of the waistcoat.

*HOW TO HOLD THE FOIL.*

The hilt must be flat in your hand ; so that the two edges are nearly horizontal when you throw yourself upon guard ;

your thumb should be stretched along the upper flat part of the hilt, within half an inch of the shell, and the pommel should rest under your wrist.

#### COMMON GUARDS OF CARTE AND TIERCE.

Stand in first position, which is similar to the first position in dancing, that is, your right foot forward, with the heel advanced; then throw yourself upon the common guard or carte, by advancing your right foot about half a yard from the left. The two heels should be in the same line. Turn your wrist so that your nails may appear upward. Let your hand be on a line with the lower part of your breast; the arm not stretched, but a little bent, and the elbow inclined a little to the outside. The point of your foil should be about fifteen degrees elevated, and nearly fixed on a line with the upper part of your adversary's breast. The left arm (which is necessary to balance the body in its different movements) must be raised in a semi-circular manner, on a line with the forehead, the hand kept open in an easy manner, the thumb and first finger nearly meeting. Your body should be sideways, and your head turned toward the right, so as to keep sight of your point. Let the balance of your body rest upon the left leg, keep the left knee bent and flexible, so that you may incline a little backward; the right knee should also be rather bent, and perpendicular to the point where your right heel rests.



The position of the guard in tierce is similar to that of carte, only the hand must be a little reversed, so that the nails may be half turned downward. The arm should be a little stretched outward, in order to secure or cover the outside, and the point should be as in carte.

### ENGAGING AND DISENGAGING.

Engaging in carte, or in tierce, is opposing your adversary's blade, either inside or outside, when you first join or cross blades on guard. Disengaging is performed by dexterously shifting the point of your foil from one side of your adversary's blade to the other; that is from carte to tierce, or *vice versa*.

### THE ADVANCE AND RETREAT.

In order to advance, move the right foot easily forward to the distance of more than a foot, and let the left foot instantly follow to the same distance; these two movements must be performed in the same moment. Keep your body firm and steady while you repeat this five or six times; and let there be a short pause between every advance. After making five or six advances, observe if the distance and position of your guard be exactly the same as your distance and position were when you commenced. In the retreat, your left foot makes the first movement backward, and your right follows at the same moment.

### THE SIMPLE PARADES OF CARTE AND TIERCE.

These are distinguished from all the others, on account of their securing the breast, as upper parades. To perform that of carte, place yourself on the common guard, and throw your hand toward the left, or inward, about six inches from guard, making a gradual turn upward with the wrist, in order to throw off your adversary's blade with the greater ease; at the same time draw your hand a little toward your body, that the opposition may be more powerful.

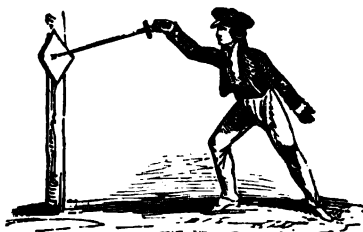
The simple parade of tierce is also performed from the common guard by throwing and stretching your arm obliquely downward to the right (or outwardly), the nails being reversed by the gradual turn of the wrist, in forming the parade. It parries the simple thrust of carte over the

arm and secunda. The distance of the hand from the common guard should be six inches. The point of your foil, your body and legs, should not deviate from the line of direction in performing either of these parades.

#### THE EXTENSION, LONGE, THRUSTS OF CARTE, CARTE OVER THE ARM, AND TIERCE.

Thrusts are, for the most part, executed with the longe, except thrusts of the wrist, and thrusts of the extension.

They may be performed either after disengaging the point or not. To perform the straight thrust of carte inside, your point must be directed to your adversary's breast, the arm well raised, and opposed



inside, the nails upward, your body projecting forward, and an extension performed of the right arm and left leg. (*Vide cut*, which represents the position of extension.) Then push home the thrust in carte by longeing out to a distance proportionate with your height. Your left arm should be stretched down by the flank, at the distance of two or three inches, and always raised as you recover upon guard, by way of grace and balance to your movements. Your body should incline a little forward; the head be raised upright, looking outward over the shoulders, so as to have a full view of the point. As you approach your adversary's breast, make a gradual resistance against his foil inward, by way of cover to your longe. Keep the right knee bent, and in a perpendicular posture with your heel; the left knee and ham stretched, with the foot firmly fixed to the ground.



To recover yourself with the requisite ease, lean with some degree of force on the heels of both feet; the greatest force is first upon the right, then it falls on the left; by bending the left knee at the same time, and inclining the body backward, you come to guard. The thrust of *carte* over the arm is performed in the same manner as *carte* inside, by disengaging to tierce, with this difference, that the head is raised upright on the inside, and the hand well opposed outward, in order to be well covered. The thrust of the tierce differs only from *carte* over the arm by reversing the wrist, the hand being well raised and opposed outward.

#### THE PARADES OF OCTAVE AND SEMI-CIRCLE.

To perform the octave parade, raise the hand as high as your chin, the nails must not be turned up so much as in semi-circle; your arm should be well stretched and thrown outward the distance of six inches; the wrist should be bent as much as possible, in order that the point may fall on a line with your adversary's flank, making nearly the same angle from guard-point as semi-circle. Semi-circle parade is useful against thrusts of low *carte*, *seconde*, and the disengage and thrust of *carte* over the arm. Let your body be steadily inclined upon the left side; drop your point, with the nails upward so as to form an angle of nearly forty-five degrees with the guard-point. At the same time, stretch your arm well out, raise the hand as high as your mouth, and throw your arm inward, the distance of six inches from the line of direction in your common guard, that your point may appear to the eye inlooking to your arm.

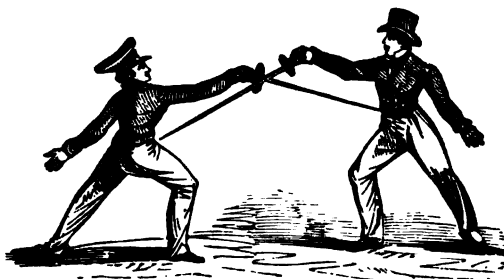
#### THE SIMPLE PARADES OF SECONDE AND PRIME.

These two parades are not used so frequently as the preceding four. *Seconde* is very powerful against the simple thrusts of low *carte* and *seconde*. To perform it from *carte*

to tierce, the nails and wrist should be turned downward, the point be dropped, and the hand opposed outward, as in the parade of octave. The point's tract from guard is also nearly the same with the parade in octave, and the inclination of the blade should form the angle of forty-five degrees. Prime is performed with the nails turned downward, the hand raised higher than the mouth, and opposed inward, in the same manner as semi-circle. The arm should be drawn well in toward the body, and the wrist bent downward, that the point may fall more than in other low parade.

#### LESSONS AND VARIATIONS IN SEMI-CIRCLE, LOW CARTE, AND OCTAVE.

On the engagement of carte, drop your point and deliver the thrust of low carte. On the same engagement your ad-



versary thrusts straight home; throw it off by parade in carte, then deliver a return of the thrust in low carte. On the same engagement disengage to tierce, and thrust carte over the arm; he opposes it with his parade, and returns a disengaged thrust in carte, which throw off with the parade of carte; then, with vivacity, drop your point and deliver a thrust in low carte. On the engagement of tierce, your adversary, by disengaging, attempts to deliver a thrust win lo

carte; throw it off by performing the parade of octave; then make a quick return of the thrust in octave.

On the engagement of carte, he thrusts low carte, parry it by octave; instantly form your extension, fix your point well to his body, and you may almost make sure of touching him. (*Vide cut.*)

On the engagement of carte, he disengages to tierce, and thrusts, throw it off by your parade of tierce; then reverse your nails upward and return a thrust in octave.

On the same engagement, he thrusts low carte; oppose it by forming your parade in semi-circle; then deliver a thrust in octave by disengaging over his arm, commonly called a counter disengagement.

#### LOW CARTE, OCTAVE, SECONDE, AND PRIME THRUSTS.

Low carte, sometimes called semi-circle thrust, is delivered after forming the parade of semi-circle, in the same manner as simple carte thrust; only the hand and point must be fixed lower. It is an excellent thrust, if your adversary have frequent recourse to his high parades.

Octave thrust is delivered after the parade of octave on the flank or belly; the arm being well opposed outward. If you parry your adversary's thrust by octave, your return will naturally be the thrust of octave, which may, at the same time, touch him with the extension only, without the longe.

The thrust in seconde is delivered after the parade of the tierce, or when engaged by tierce, by dropping your point under your adversary's wrist with the nails downward; longe and deliver the thrust on the flank.

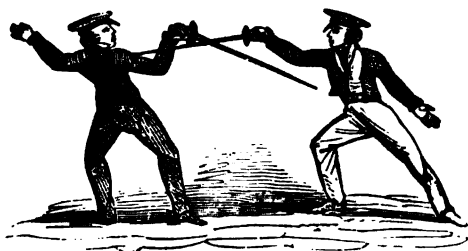
Prime is the natural thrust in return, after having parried your adversary's force, when advanced considerably within his measure, and pressing vigorously upon you. It is only an extension of the arm from the opposition of the parade to your adversary's body, the nails being kept downward. The arms should be well raised and opposed inward.

**VARIATIONS AND LESSON ON ENGAGING AND  
DISENGAGING, ADVANCING AND RETREAT-  
ING, SIMPLE PARADES, AND THRUSTS OF  
CARTE AND TIERCE.**

Suppose you are engaged in carte with an adversary ; he retreats ; you advance, well covered in carte ; he retreats again ; you advance with a disengagement to tierce, and so forth, alternately, taking care that you are properly covered on each engagement ; his retreat and your advance should be comprehended in the same moment of time ; in the same manner, you may retreat while he advances. On the engagement of carte, your adversary delivers a thrust in carte ; oppose it by forming your parade in carte, then return the straight thrust thereof. He again thrusts straight in the same manner ; also throw it off by forming your parade in carte ; deliver in return the thrust of carte over the arm by disengaging to tierce. On the engagement in tierce, he disengages and thrusts carte inside ; throw it off by your parade in carte, disengage, and thrust cart over the arm ; he parries, and returns in tierce, which you parry by a parade in tierce, and longe home with a straight thrust in tierce.

**LESSON AND VARIATIONS IN PRIME AND  
SECONDE.**

On the engagement of tierce, your adversary advances



within his measure and delivers a thrust in tierce or carte

over the arm; oppose his blade by the parade of prime, and return a thrust in prime. (*Vide cut.*)

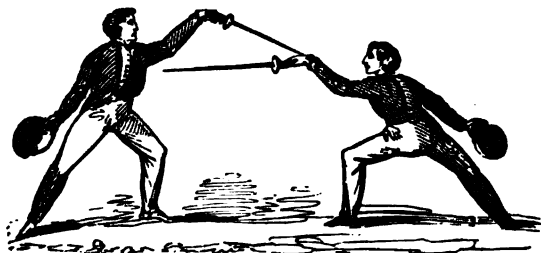
On the same engagement he advances, disengages, and forcibly thrusts carte; drop your point, and parry it with prime; then disengage over his arm and return a thrust in seconde.

On the engagement of carte he disengages, and thrusts carte over the arm; parry it with simple tierce, and return a thrust in tierce; he advances, as you recover, within his measure, forcing upon your blade; form your parade in prime, and deliver a quick return of the thrust thereof. On the same engagement he again disengages, and thrusts carte over the arm, which parry with tierce, and return the thrust thereof; he forces a thrust without advancing, parry it with prime, then disengage over the arm and return your thrust in seconde.

#### THE SALUTE.

Place yourself on guard, engage your adversary's blade on the outside; by way of compliment, desire him to thrust first at you; then drop your point by reversing the nails downward, with a circular motion; draw your right foot close behind the left, stretching both hams; raise your right arm, and with your left hand take off your hat gracefully; then make a circular motion with your wrist, with the nails upward, while you advance your right foot forward, forming your proper extension. Your adversary makes the same motions, keeping equal time with you, but instead of forming the extension, he makes a full longe, as if going to thrust carte inside, in order to take his measure, presenting his point at a little distance from your body while you remain uncovered on the extension. (*Vide cut.*)

When your adversary recovers his position, after having taken his measure, you also recover by drawing the right foot or heel close to the heel of the left; the right hand well stretched and raised, the nails upward and the point dropped; the left hand raised in a semi-circular form, as if

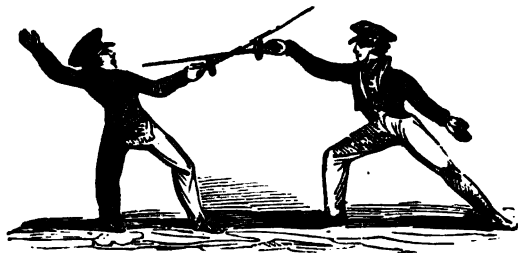


on guard, your hat held therein with ease and gracefulness; the head upright and the hams stretched. In this attitude salute first in *carte*, by forming the *parade*, then salute in *tierce*, by forming the *parade of tierce*; lastly, make a circular motion with the wrist, by dropping your point in *tierce*, at that moment putting on your hat, and throwing yourself upon the *guard of carte*.

When it is your turn to push, the salute only differs in one particular from the above; that is, instead of forming the extension, and uncovering the body, you make a full lunge from the first position of the right foot behind the left in *carte*; then, recover to the second position, by placing the right foot or heel close to the heel of the left; and conclude with the other movements. All these motions should be performed with ease, grace, and without precipitation. After performing the salute, and being engaged in *carte*, your adversary, agreeably to the compliment offered, pushes at your breast by disengaging nimbly to *tierce*, and thrusting *carte* over the arm. Observe, that the wrist is never reversed when he disengages; oppose it by performing the *parade of tierce*, then drop the point, by way of accustoming yourself to make the return in *seconde*, which may be termed the *grace on the parade of tierce*. Remain on this *grace* till your adversary recovers to guard; then join his blade in *tierce*; he disengages, by thrusting *carte* inside; throw it off by forming the *parade of carte*.

The grace or ornament to be used after forming this parade, while your adversary is upon the longe, is by allowing the foil to remain flexible in your hand, with the point downward, keeping your hand in the same direction as if covered upon the parade.

Your adversary, after pushing tierce and carte alternately, commences the salute; and while he is on the extension, you take the measure by longeing in carte. Having joined blades in carte, disengage, and thrust carte over the arm. Again, he joins your blade in tierce, disengage nimbly, and thrust carte inside. (*Vide out.*)



He opposes in carte; then let the blade and point fly loosely over the hand having hold of your foil between the thumb and two first fingers, by which you will have a view of your adversary through the angle made thereby. This is the grace upon the longe of carte inside.

#### FEINTS.

Feints are used to oblige your adversary to give you openings. The simple feint, *une, deux* (or one, two), is performed by two separate disengagements, either on the engagement of carte or tierce, when your adversary throws his simple parades. If engaged in carte, disengage closely to tierce, then quickly disengage back to carte, and deliver the thrust thereof. On the engagement of tierce, disengage first to

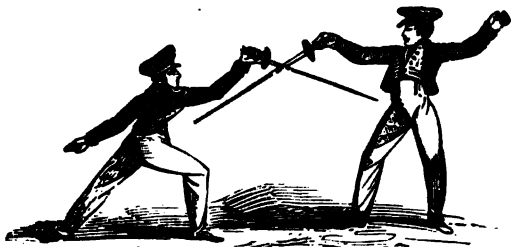
carte, then disengage back to tierce, delivering the thrust of carte over the arm.

Feint seconde, carte over the arm, is performed when engaged in tierce, by dropping your point, and reversing the nails, as if you meant to thrust seconde; then quickly turn them upward, and deliver the thrust of carte over the arm. On the same engagement, you may mark feint seconde, and thrust carte inside, if there be an opening.

Feints une, deux, trois (or one, two, three), are performed by three separate disengagements, either from the engagement of carte or tierce. On the engagement of carte, mark feint, one, two, as above; if your adversary form his simple parade of carte, nimbly mark your third disengagement, by thrusting carte over the arm. On the engagement of tierce, disengage three times, and deliver your thrust in carte inside.

#### COUNTER-DISENGAGEMENTS IN OCTAVE AND SEMI-CIRCLE.

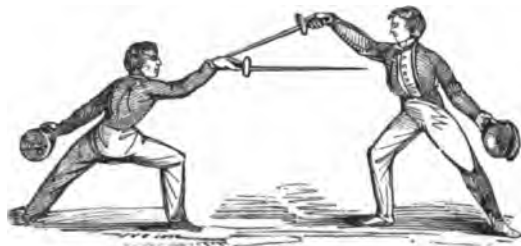
The counter-disengagements in octave may be performed after your adversary has thrust in seconde, and you have parried by semi-circle; as he uncovers, counter-disengage, and thrust in octave. (*Vide cut.*)



To give a further exemplification of the counter-disengagement in octave, it is also performed by first making a feint, as if you intended to thrust octave; he naturally opposes it, by forming his parade in octave; then nimbly dis-



engage over his arm to carte inside, and deliver either that thrust, or the thrust of low carte.



The counter-disengagement in semi-circle is performed on the engagement of carte, when your adversary accustoms himself to take the parade of semi-circle, by first making a feint, as if you meant to thrust low carte, which he attempts to parry with semi-circle, then nimbly disengaging over his arm, and delivering your thrust in octave.

#### THE COUNTER, OR ROUND PARADES, IN CARTE AND TIERCE.

The counter-parade in carte, is esteemed one of the most essential, as it baffles a variety of thrusts, throws off the disengagements over the arm, etc. In order to perform it when your adversary disengages, follow his blade closely, with a small circle, entirely from the motion of the wrist, by which you join his blade always in carte. If he make a thrust with the disengagement, oppose it, by gradually covering yourself with the parade of carte after having followed his blade round.

The counter, or round parade in tierce, is performed in a similar manner to the counter-parade of carte, only that the course of the point is reversed. For example: your adversary disengages to carte, with a view to thrust carte inside; follow his blade closely, with a small circle, made by the motion of the wrist reversed in tierce, stretching your

arm, and giving his blade a smart and abrupt throw-off, as you overtake or meet it in tierce. The course of the point in forming the counter in carte is inward, from left to right; and in the counter-parade of tierce, the contrary.

#### THE COUNTER-DISENGAGEMENTS IN PRIME AND SECONDE.

The counter-disengagement in prime is seldom used in attacks; but being so nearly related to prime parade and thrust, we shall here describe it. It is performed from the engagement of tierce, by forcing on your adversary's blade, if he betake himself to the parade of prime, then nimbly disengaging over his arm, and delivering your thrust in seconde.

The counter-disengagement of seconde may be more frequently used; it is performed from the engagement of carte, by dropping your point, or making a feint, as if you intended to thrust prime: your adversary opposes it, by performing the parade of seconde; then disengage over his arm, and deliver your thrust by longeing in prime.

#### LESSONS AND VARIATIONS ON THE COUNTER- PARADES IN CARTE AND TIERCE, AND THE COUNTER-DISENGAGEMENTS IN OCTAVE, ETC.

On the engagement of carte, disengage and thrust carte over the arm; your adversary opposes it, by forming the counter-parade of carte. Upon recovering, he, in return, disengages and thrusts carte over the arm; oppose it by counter-parade in carte, etc.; disengaging and parrying alternately, always making complete longes with the thrusts, and moving well to guard, while forming the counter-parades. Make your movements very slow and exact in the beginning, and gradually quicken them. Exercise on the engagement of tierce in the same manner: first, by disengaging and thrusting carte inside, which he opposes by forming the counter-parade in tierce; in return, he disengages and thrusts carte inside, which parry with the counter-parade in tierce, etc.: thrusting and parrying as above,

until you quicken your movements with all possible exactness.

On the engagement of tierce, if your adversary thrusts octave in low carte, you may parry it with octave; then counter-disengage, and deliver a thrust in low carte. On the same engagement, he counter-disengages, and thrusts low carte, which oppose by your counter-parade in octave, and return the thrust thereof. On the same engagement, he again counter-disengages, and thrusts low carte, which you may baffle by first forming the parade of octave, then forming the parade of semi-circle quickly after the other; and, as he recovers, counter-disengage, and thrust octave.

On the engagement of tierce, advance within measure, forcing upon your adversary's blade; he betakes himself to the simple parade of prime; counter-disengage and thrust seconde. On the same engagement, he advances, forces, and counter-disengages as above; but baffle his thrust in seconde by the counter-parade in prime, and return the thrust thereof. On the same engagement, he counter-disengages; follow his blade by the counter-parade in prime; if he attempt to double or disengage again, stop him, by forming your simple parade of seconde.

On the engagement of carte, counter-disengage, when your adversary drops in seconde, and thrusts prime. On the same engagement, he counter-disengages, when you drop to seconde; oppose it, by your parade of seconde; then return a straight thrust in seconde. Or if, on the same engagement, he make a straight thrust in seconde, you may parry it with semi-circle, and return low carte thrust. On the same engagement, he counter-disengages, answer his movements by forming the simple parades of seconde and prime; then counter-disengage as he recovers, and deliver a thrust in seconde.

#### CUT OVER THE POINT.

This is performed when you perceive your adversary hold his hand low and his point is raised upon guard. To perform it from carte to tierce, raise your point quickly, with the up-

ward motion of your wrist, fairly over your adversary's point, without moving your arm from the line of direction, at the same time forming your extension, and deliver your thrust of carte over the arm.

In the same manner you may execute cuts over the point from the engagement of tierce, when your adversary holds his point high.

#### THRUST OF THE WRIST.

This is performed when you perceive your adversary slow in making a return, after you have longed with a thrust; as on the engagement of carte, suppose you thrust carte over the arm, which your adversary naturally parries with simple tierce, lean with some degree of force upon his blade, and, as you recover to guard, deliver him a thrust with the wrist in seconde.

#### RETURN ON THE EXTENSION.

This is performed after your adversary makes a full longe with a thrust, which you may parry so powerfully, as to throw his arm out of the line of direction; then, with all possible quickness, extend your arm, and deliver him a straight thrust in return, before he has time to recover. If the extension of the arm be not within reach, form your complete extension of the leg and arm.

#### APPELS, BEATS ON THE BLADE, AND GLIZADES.

Appels, beats, and glizades, tend to plant you firm upon your guard, to embarrass your adversary, and cause him to give you openings; they are performed previously to simple thrust, feints, or counter-disengagements, etc. An appel, or beat with the foot is performed either on the engagement of carte or tierce, by suddenly raising and letting fall the right foot, with a beat on the same spot; taking care to balance the body, and keep a good position on guard.

The beat on the blade, is abruptly touching your ad-

versary's blade, so as to startle him, and get openings to thrust. If he resist the beat, instantaneously disengage, and thrust home. If he use a simple parade, mark feint one, two ; or, if he use a counter-parade, counter-disengage, or double.

Glizades are slightly gliding your blade along your adversary's, at the same time forming the extension of the arm, or the complete extension, managing and restraining your body, so as to be aware of his thrust, and to make sure of your own. If you be engaged in carte, out of measure, a quick advance, with a glizade, must infallibly give you some openings, either to mark feints or otherwise.

#### THE TIME-THRUST.

This thrust is performed when your adversary is dilatory. On attempting to deliver this thrust, cover yourself well, by forming a gradual and strong opposition to your adversary's blade; you can be in no danger of exposing yourself to an interchanged thrust, that is, a thrust at the same moment.

#### LESSONS AND VARIATIONS TO FEINTS, APPELS, ETC.

On the engagement of carte, mark feint one, two, and thrust carte inside. On the engagement of tierce, feint one, two, and thrust carte over the arm. On the engagement of carte, mark a feint over the arm, and thrust low carte. On the same engagement, mark feint over the arm, reverse the wrist, and thrust seconde.

On the engagement of tierce, mark feint seconde, reverse the wrist, and thrust carte over the arm. On the same engagement, mark feint seconde, and thrust carte inside. On the engagement of carte, in attempting the feints one, two, if he baffle it by his counter-parade in carte, counter-disengage, and deliver the thrust of carte over the arm.

On the engagement of carte, suppose your adversary hold his guard low, and his point high, make a cut over the

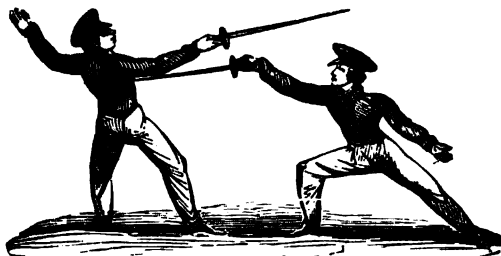
point, forming your extension, and thrust carte over the arm. On the engagement of carte, cut over the point; if he use a simple parade, disengage, and thrust carte inside. On the engagement of tierce, if your adversary hold his hand low, and point high, make a cut over the point, and thrust carte inside. On the same engagement, cut over the point twice, and deliver the thrust of carte over the arm. On the same engagement, cut over the point twice, then disengage, and thrust carte inside. On the same engagement, cut over the point, then mark feints one, two, and thrust carte inside.

On the engagement of carte, disengage to tierce, and thrust carte over the arm; if your adversary form his simple parade in tierce, and be slow in making a return, deliver him a thrust with the wrist in seconde, as you recover. On the engagement of tierce, disengage and thrust carte inside, or low carte; if he parry it with octave, disengage over his arm as you recover and deliver him a thrust in low carte. On the engagement of carte, disengage and thrust seconde; if he parry it with seconde, counter-disengage as you recover, and thrust prime. On the engagement of tierce, force upon his blade, disengage and thrust low carte; he parries it with prime, and if slow in making a return, deliver the thrust in seconde with the wrist, as you recover.

On the engagement of carte, give him some openings; if he mark the feints one, two, and thrust, form your counter-parade in carte; then deliver him a quick return with wrist in low carte, by forming the complete extension. On the engagement of tierce, in like manner, give him some openings; if he mark feints one, two, and thrust, form your counter-parade in tierce; and, on the extension, deliver him a thrust in seconde. On the engagement of carte, if he execute low feints and thrusts, use the circle parade, and return a straight thrust on the extension before he recovers.

On the engagement of carte, make an appel, or beat with the right foot at the same time beating abruptly on your adversary's blade, which will give you an opening to thrust carte straight home. On the same engagement, make an

appel, beat his blade, then disengage, and thrust carte over the arm. On the engagement of tierce, make an appel, beat his blade, and thrust tierce or carte over the arm. On the same engagement, make an appel, beat his blade, then disengage, and deliver a thrust in carte inside. On the engagement of tierce, make your appel, disengage to carte, by beating his blade, and thrust carte inside.



On the engagement of tierce, perform a glizade along his blade, with the extension; if he do not cover himself, deliver a straight thrust in carte over the arm. On the engagement of carte, make a glizade, drop your point, and deliver a thrust in low carte. On the engagement of tierce, perform a glizade, drop your point under his wrist, and deliver a thrust in octave.

On the engagement of tierce, he disengages to carte, then disengage contrarily, and thrust home carte over the arm. On the engagement of carte, when you find that your adversary holds his hand too low upon guard, and deviates from the guard rules, seize the opening, by pushing carte straight home. On the engagement of tierce, having the like opportunity, deliver the thrust of carte over the arm, straight home.

On the engagement of carte, your adversary disengages to tierce; that instant disengage contrarily (that is, to carte) and push home. (*Vide out.*)

All these lessons should be performed repeatedly, and the

pupil should often exercise with another who has had equal practice, executing all thrusts, feints, counter-disengagements, etc., while the other remains upon guard, making use of the necessary parades, etc.; he should then, in turn, perform the practical movements, in order that both may make mutual progress in the art.

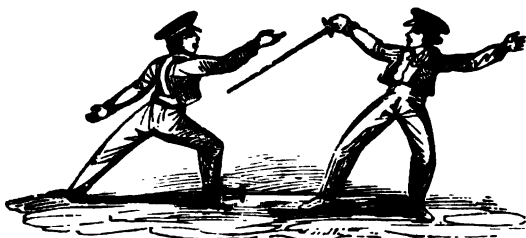
#### THE SALUTE PREVIOUS TO ASSAULTS.

On the engagement of tierce, make two quick appels, or beats, with the right foot; bring it close behind the left, near the shoe-tie, raising and stretching your right arm with the nails upward, and the point of your foil dropped; at the same time, take off your hat gracefully, and hold it in your left hand, stretched down near the flank; then, with a circular motion of the wrist, as if forming the counter in tierce, throw your left foot backwards, to the distance of your common guard, and raising your left hand, make two other appels; bring your left foot forward to the former position, that is, before the right, near the shoe-tie; at the same time stretching your arm, with the nails upward as before, and in that position, form gracefully the parades of carte and tierce; make a circular motion with the wrist, and advance your right foot, with vivacity, to your original guard, at the same time covering your head. All the movements in this salute should be performed in a more lively manner than those described in the salute previously to thrusting carte and tierce: observe, also, that these movements should keep exactly the same time with those of your adversary.

#### DISARMING.

After parrying your adversary's thrust by simple carte, or the counter in carte, without quitting his blade, lean abruptly thereon, and binding it with yours, reverse your wrist, with the nails downwards, as if in seconde, and with the motion thereof give his blade an abrupt twirl. (*Vide out.*)





If this do not disarm him, it will throw his hand and blade out of the line of direction, so that you may effectually fix your point, and deliver him a thrust in seconde.

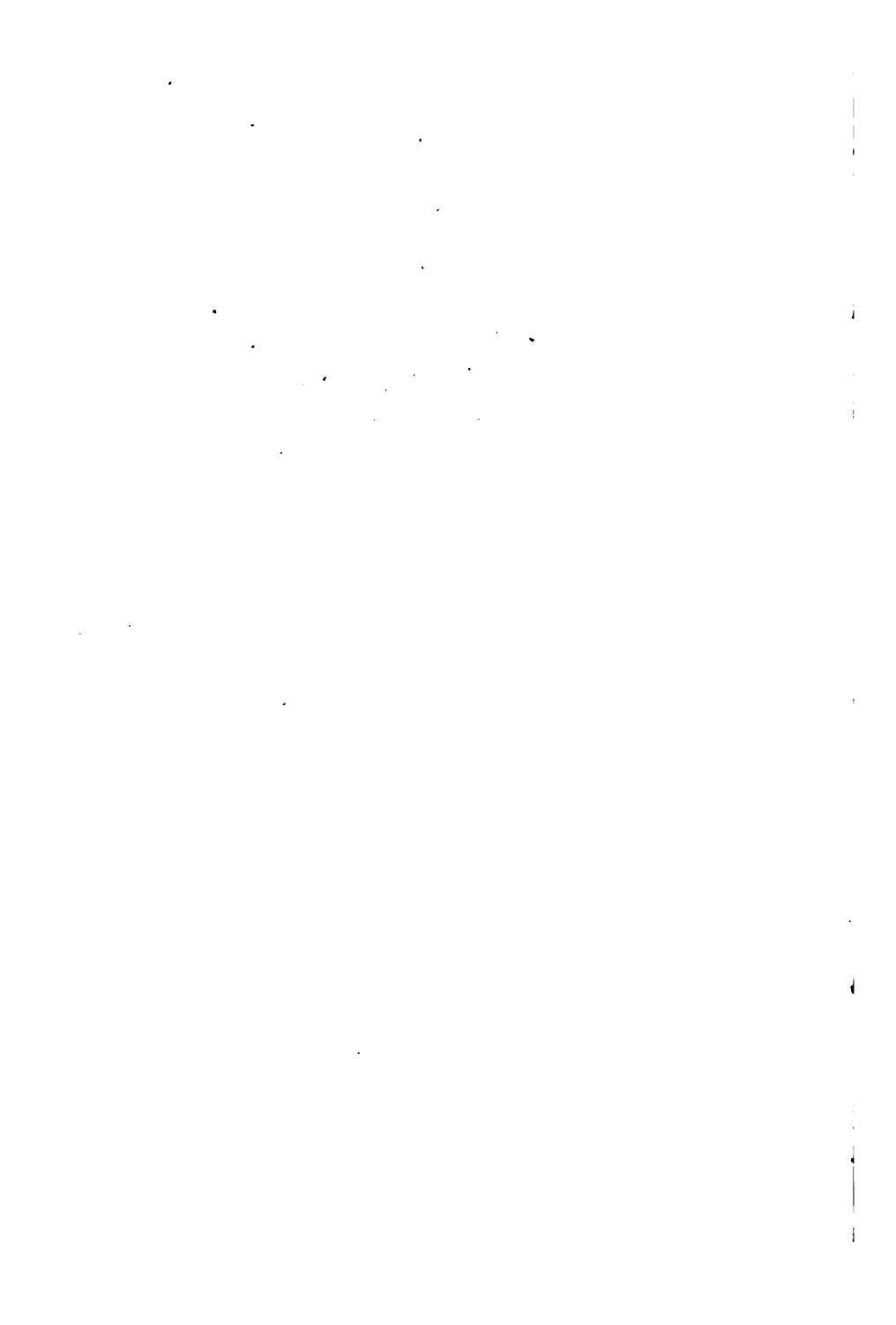
Also, after parrying by simple tierce, cross his blade before he recovers; make a strong and abrupt circular movement with your wrist in seconde without quitting his blade, and it will either disarm, or give you an opening to deliver him a thrust.

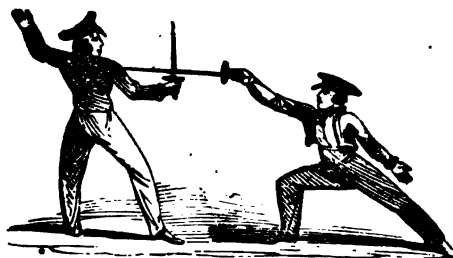
#### PRACTICAL OBSERVATIONS.

Assume a bold air and steady position; fix your eyes firmly on those of your adversary, so that he may not penetrate into your designs; and keep your proper distance and measure. It is a most essential point in assaults, exactly to know these; for this purpose, observe the height of your adversary, the length of his foil, etc., and make the necessary allowances accordingly. If he make frequent practice of disengaging, beating your blade, and otherwise embarrassing you, with a view to get openings, you may seize the occasion to deliver a time-thrust, taking care to cover yourself well, by forming a good opposition against his blade. When on the engagement of carte, by way of snare, hold your point higher than usual; if he attempt to make a cut over the point, that instant disengage contrarily and thrust carte inside; or you may, in preference to this, deliver a straight thrust in carte over the arm. (*Vide cut.*)

Be not too eager in making your thrusts in return; as, by







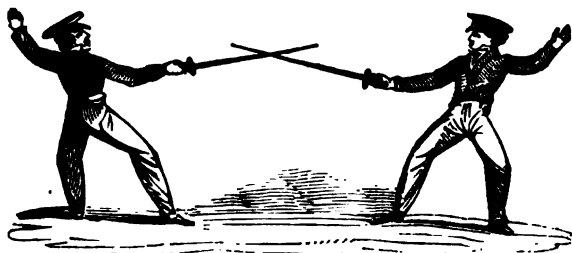
an over-eagerness, learners contract a habit of returning their thrust by crooking the arm, which is quite erroneous. Form your parades justly, and accustom yourself, at first, to make straight returns without disengaging. If you intend to return a thrust by disengaging, you should perform it the moment your adversary is recovering; it must proceed from the motion of the wrist, and not by crooking the arm. The distance of your guard should be moderate, two feet is the distance for men; by a wide guard, you keep your adversary at too great a distance, and have not that necessary command of throwing your body back far enough, when he advances and makes a full longe; neither can you retreat, or make returns with the necessary quickness; the lower part of the body is also more exposed than it would be on a proper medium guard.

Never extend yourself too far on the longe, as it impedes your recovering to guard with the necessary quickness. Always endeavor to recover quickly, and with as much ease as possible, fixing your point to your adversary's body, and forming the most natural parade, in case he should make a quick return. If engaged with an adversary of a shorter stature, attack him on the engagement of tierce, as being more advantageous for a number of feints and thrusts than the engagement of carte, particularly for feint seconde over the arm, etc.

If your adversary advance within his measure, and force

in a straight thrust, *carte* over the arm, or in *tierce*, then raise and bend your arm, forming the parade of prime, and quickly return a straight thrust in prime, before he recovers; or, if you have not opening sufficient, disengage over his arm, and deliver a thrust in *seconde*.

When you first enter upon the assault, you may engage your adversary's blade out of measure in *carte*, as being easier than the other engagement, for executing your different movements. (*Vide cut.*)



When you engage your adversary's blade, act on the defensive for some time, in order to discover what feints or thrusts he prefers. Vary your parades as much as possible, so that he may not, in turn, ascertain your own favorites; for, if a good fencer be found to use one parade in preference to another, he may be deceived with much less difficulty than might be imagined, and, eventually, be touched, by a person far less skillful than himself. A learner, therefore, should practise all the parades, and change them continually, or, at least, as often as opportunities occur. He should endeavor to go from the high to the low parades, and from the latter to the former, with the utmost possible agility, until, by practice, he is enabled to parry almost every thrust.

If you engage the blade in *carte*, cover your inside a little, and if in *tierce*, cover your outside, to prevent straight

thrusts on those engagements. When attacking, it is well to disengage dexterously, outside and inside, forming your extension as if you intended to thrust; if this plan do not afford you some openings, it will, at least, in all probability, be the means of discovering your adversary's choice parades. If he use simple parades only, you may easily deceive him by making feints one, two, or one, two, three. If, on the contrary, he be a skillful fencer, and use various counter-parades you must endeavor to embarrass him, by appeals, beats on the blade, extensions, glizades, counter-disengagements, etc.

#### KNIGHTS.

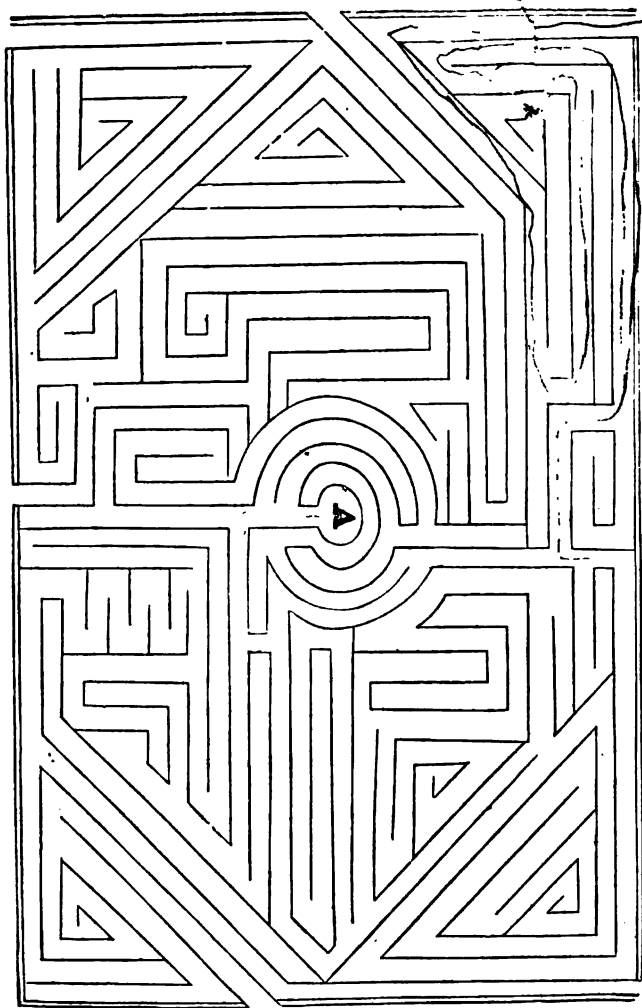
Two sturdy boys take each a smaller boy on their backs, and engage in a mock tournament, themselves acting as horses, while the youngsters grapple and strive to unseat each other.

The real brunt of the fighting falls on the horses, upon whose strength and dexterity, much more than upon that of their respective "Knights," depends the ultimate issue of the combat. The horses may shove and jostle one another, but must not kick, trip, or use their hands or elbows.

The victor is he who gains most falls in three rounds. The game should only be played upon turf, for safety's sake; for sometimes, when horse and man go down together, the fall might prove a nasty one on hard ground, and at any time the rider is liable to be brought off backwards with a jerk, under which circumstances he will be thankful to measure his length on the soft turf, instead of lumpy gravel or unyielding pavement.

#### ROSAMOND'S BOWER.

This cut represents, it is said, the Maze at Woodstock, in which King Henry placed Fair Rosamond. It certainly is a most ingenious puzzle, and consists in getting from one of the numerous outlets, to the Bower in the centre, without crossing any of the lines.



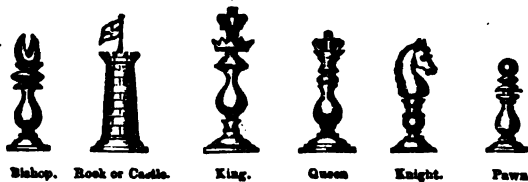
ROSAMOND'S BOWER.

*CHESS.*

Chess, of all sedentary games, is undoubtedly the most eminent. Various accounts have been given of its origin. Some say it was first played at the siege of Troy, being invented by Palamedes to amuse the Grecian chiefs, disgusted with the tediousness of the siege; but the most probable conjecture is that of Bochartus, who makes it of Oriental extraction, and to come to us from Persia through Arabia; as most of the terms employed in the game are either corruptions or translations from the Persian or Arabic words. Thus, check is plainly derived from the Persian *schach*, or king; and *mat*, in the same language, signifies dead; hence check-mate, or, the king is dead.

Chess is highly beneficial to the improvement of the mind; nothing in it is governed by chance—judgment is everything. A player, therefore, cannot lay the blame of his losing on fortune, but must ascribe his miscarriages to deficiency of judgment, or inattention; and for this reason it is the most interesting of games. It acts strongly, too, on the sense of honor; irascible persons should therefore avoid it, unless they have learnt to acknowledge that the acutest minds may be guilty of an oversight. Chess has one splendid advantage over almost all other sedentary games: that its lovers do not play at it for wagers, the honor of the victory being the only reward of the conqueror.

## THE VARIOUS PIECES.



We now proceed to give a description of the various char-



acters which constitute the little armies on the chess-board. Each party has a king, queen, two rooks or castles, two bishops, two knights and eight common men or pawns. The above are their representatives.

### THE KING.

The king is the most important piece at Chess; the sole object of the game is to hem him in, so that he cannot move without going into such a situation as would render him liable to be taken if he were not a king. He is then checkmated, and must surrender. He steps only from one square to the next at a time, but in any direction whatever, either forward, backward, sideways, or diagonally. He can also take any of the enemy's men in any square adjoining to him, so that he does not place himself in check; that is, in such a situation as, if he were not a king, he could be taken by the enemy. The king, however, is never actually taken; but if he be checked by one piece, and can neither take the hostile man, interpose any of his own, nor move into any other square without being in check from another, he loses the game. Whenever the king is in check, the adversary must say "check," to him, which is a warning either to defend himself by his other pieces, to take the man who assaults him, or to move into a place of safety.

### THE QUEEN.

The queen is, in point of power, the best piece on the board. She moves, like the king, in all directions, and as far as she pleases, but at one move, and provided the squares be unoccupied in her line of motion.

### THE ROOK, OR CASTLE.

The rooks or castles, are next in importance to the queen. Their motion is backward, forward, and sideways, and they may move as far as the field is open.

### THE BISHOP.

The bishop moves diagonally, as far as the squares are open, in any direction. The bishop, therefore, always keeps the same colored squares as that on which he is placed at the beginning of the game.

### THE KNIGHT.

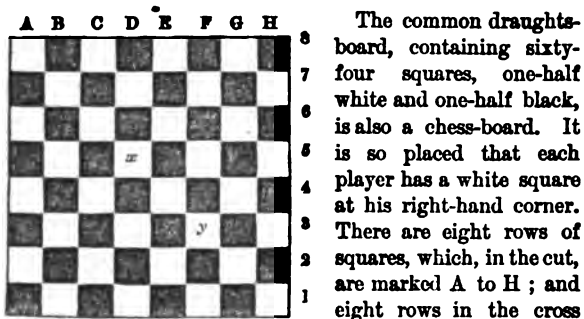
The knight is particularly useful at the beginning of the game, and should be one of the first pieces brought into play. The knight moves in a peculiar way, leaping from the square on which he stands into either of the next that has a corner in contact with one of the farther corners of the square over which he leaps. He always moves, therefore, from white to black, or the contrary. As, for an example, from B 1 to A 3, C 3, or D 2. The move of the knight is one of the most difficult points of chess to explain in writing; and we therefore recommend our young friends to take an opportunity of looking over a game of chess while playing, and fix the whole of the moves in their minds. A knight may be placed on any one square of the board, and conveyed hence into every one of the other squares in sixty-three moves. We subjoin an example of this curious problem at the end of the article.

### THE PAWNS.

The pawns are of great consequence in defending the king; and are very useful in attacking and repelling the pieces, under the management of a good player. If a pawn can proceed across the field to the rear line of the enemy, that is, from 2 to 8, or from 7 to 1, he is exchanged for a queen, or any other piece of his color that he chooses to demand. Thus, you may have a second queen, even though you should have lost none of your pieces. The pawn moves straight forward, and only a single square at a time; except on its being first moved, when the player may advance it either one square or two, as from 2 to 3, or to 4, and from 7 to 6, or to 5; or when one takes a man from

the enemy, which is always done diagonally, or across the corners of the squares. But a pawn cannot move two squares forward, when the square over which he leaps is so viewed by an enemy's pawn, that the latter could take him in that square. For example, the pawn G 2 cannot be moved to G 4, if there be an enemy's pawn on H 4 or F 4, without that pawn's having option of taking him on G 3, as he passes.

### THE CHESS-BOARD.



direction, 1 to 8. Thus, any square may be readily pointed out ; for instance, the square *x* on the figure will be indicated by D 5 ; and if a man were to be moved from *x* to *y*, this would be expressed by the words "from D 5 to F 8." The letters and figures should be written on the margin of the board, or a pasteboard, for practising the games and situations hereafter described.

There is another mode of indicating the squares, by the pieces that occupy them at the commencement ; this it may be as well to insert. The square in the corner, at the right hand of the player who has the white men, is the white king's rook's square ; that before it, the white king's rook's second square ; the next, his third square ; and the following, his fourth square. This meets the black king's rook's fourth square ; and thus the row proceeds, through

the black king's rook's third and second squares, to the black king's rook's square at the left-hand corner of the player with black. The same mode is adopted by all the rest; the pieces on the queen's side of the board being distinguished as the queen's rook, knight, and bishop.

#### PLACING THE MEN ON THE BOARD.

The rooks occupy the four corners of the board; the knights stand next to these; the bishops next to the knights; the queens on D 1 and D 8; and the kings on E 1 and E 8. Thus, the pieces or officers, stand opposite each other respectively, at different sides of the board; the queens being on the squares of their own color, and the kings the contrary. The row immediately in front of the officers is occupied by the pawns. The value of the men has been estimated as in the following proportion to each other:—the queen, 95; a rook, 60; a bishop, 39; a knight the same as a bishop; the king (estimated as a fighting piece) 26; a pawn, 8, or rather more, from its chance of promotion, by being moved to a square that entitles its player to exchange it for a queen or any other piece he chooses to demand.

#### LAWS OF THE GAME.

1. Each player marches his men forward, gradually, against those of the enemy, or retreats when the game is open behind them, except only as regards the pawns, which can only move forward. Each party moves alternately, one man at a time.

2. In each game, the players have the first move alternately, except where one gives the other the advantage of a piece or a pawn, in which case, the party by whom such piece or pawn is given is entitled to the first move.

3. If you misplace your men at the beginning, and play four moves, your adversary may permit you to begin the game afresh, or not as he pleases.

4. If you touch a man, you must play it, except it would discover check on your king; in which case you can only

move the king, if it be practicable. When you have taken your hand from your man, he must remain where he is; but as long as you keep hold of him, you are at liberty to place him where you please, though you may have set him down upon a square.

5. If you touch one of your adversary's men, he may insist upon your taking it, if you can; if not, you must move your king, if that be possible, without putting him in check.

6. You cannot castle after moving the rook or king; if you attempt to do so, your adversary may insist on your moving one of those pieces, at his option.

7. If you make a false move, such as moving one of your opponent's men in mistake for one of your own, taking off one of your own pieces instead of his, etc., your opponent can oblige you to replace such move, and move your king, if you can do so without placing him in check; but if he have played before he notices your false move, neither of you can afterwards recall it.

8. If your opponent challenge you with a check without, in fact, your king being in check, and you, in consequence, move your king, or any other man, you may retract such move if you discover it before he has made his next move.

9. If your adversary give you check without warning, or saying "check," you are not obliged to notice it till he does; but if, on his next move, he warn you, each party must retract his last move, and the check be provided for as if just given.

10. You must not check the opposite king with any piece, by moving which to do so you expose your own king to a check.

11. If the king be not in check, but cannot move without going into check, and have no piece or pawn left, or even none that can be moved, he is stale-mated, and the game is drawn.

## PLAYING, CHECKING, CASTLING, ETC.

It is usual to begin with advancing the king's pawn two squares, that is, from E 2 to E 4, or from E 7 to E 5; because this opens the way for the king's bishop and the queen. It is, however, perfectly optional; this, as well as all the rest of his moves, being regulated either by some plan which the player has formed for attacking his enemy, or as he may find a necessity of defending himself from his enemy's attack. The object of the game, which is to give the enemy check-mate, can scarcely be effected without some settled plan. The player must look forward through a considerable number of moves, which will be requisite to bring his men into a given position, and also to provide, from time to time, against his-antagonist's attempts to frustrate his design or attack him in turn. He must seek to penetrate his adversary's plots from the moves he makes. He is not obliged to take a man when it is in his power; but, when he does, the man with which he takes it, must be placed on the square occupied by the man taken. When the king is in such a situation that another move could take him, were he not king, he is in check. The modes of extricating the king from check are as follows:—If the man that checks him be in an adjacent square, the king may take such man if he be not guarded; that is, if another man of his own color have it not in his power to move into the square in which the man is placed if he be removed from it; since, in this case, the king would place himself in check again. For example, suppose the king in E 1, and an enemy's pawn, advanced to D 2, give him check; the king cannot take the pawn, if the enemy have another pawn, or a bishop in C 3 or E 3, or a rook or queen anywhere in the open row D D, etc. The man that checks may also be taken by some other man, to whose attack he is open; or a man may be placed between the king and the checking man (unless it be the knight) if there be a vacant square between them. Lastly, the king may be moved into another square which is not commanded by the adversary's pieces. The king is check-mated, and

the game is lost, if he cannot extricate himself by either of these moves. A king cannot go into a square next the opposite king; he cannot therefore give check; because, in doing this, he would go into check himself.

Castling is allowed once in a game. It consists in moving the king two squares to the right or left, and bringing the rook on that side to the square adjoining the king on the other. Thus the king may be moved from E 1 to G 1, and the rook brought from H 1 to F 1; or the king may be moved to C 1, and the rook from A 1 to D 1. Castling is not allowable when the king, or the rook with which you would castle, has been moved; when the king is in check, or when the king must pass over a square in which he would be checked. Suppose the king would move from E 1 to G 1, he must pass over F 1. But, if there be a queen or rook of the enemy anywhere on the row F, as far as it is open; or, in short, if F 1 be commanded by any one of the enemy's men, the king cannot castle on that side, neither can he do so when there is a man between himself and the rook.

#### GENERAL INSTRUCTIONS.

If the king's pawn be advanced two squares, and the queen's one square, an opening is made both for the queen and the queen's bishop to the king's side of the board; and the king's pawn cannot be taken without the queen's pawn taking the adversary's man in turn, and supplying his place. If two pawns be advanced side by side, neither defends the other; this is sometimes done to further a plan of attack; the pawn sacrificed on these occasions is called the gambit pawn. After the pawns are advanced a certain way, the knights may be brought forward, either to support them, or act upon the offensive.

The plan of attack should be gradually formed from the commencement of the game, and each step taken should have a tendency to forward it, unless when it is necessary to thwart the plan of the adversary. The player must not suffer himself to be diverted from a well-concerted project

by any collateral advantage; for the taking of a pawn or piece may prove injurious when it leads to a deviation from the principal object. If your plan be discovered and frustrated, it is better to form a new one than to persevere in the old. Your plan should not only be concealed from your adversary, but you must also discover, if possible, what your adversary can do to counteract your moves. A plan may be most effectually concealed by excluding the queens and rooks, or by executing it through the agency of inferior pieces or pawns, or by masking the pieces intended to effect it behind men which are apparently indifferent. The skilful player, if his moves be calculated with precision, will sacrifice his most important pieces without hesitation, to mislead his antagonist, or, when necessary, to the accomplishment of his plan; nay, he will often do this intentionally, to lead his opponent into the hope of winning, and give his antagonist check-mate, when he fancies he has the game in his hands. To give check without having it in your power to follow it up, is, in general, bad play. If your checking piece can immediately be repulsed, you lose a move; never proceed to an attack therefore without good preparation; and if your attack proceed well, do not suffer yourself to be drawn aside after any bait that your antagonist may throw in your way. The object in chess is, to give check-mate, and not to take pieces. Sacrifice your own willingly, when the loss of them will open the line of defence adopted by your opponent.

If a man of the enemy be exposed, examine whether it were left so from necessity, oversight, or design. You do not always gain by taking a piece, you may be check-mated in consequence of taking even a queen. Be not eager to take a pawn in front of your queen; for, as your antagonist cannot take him, he is frequently a better protection than a man of your own. If you cannot save a piece, endeavor to take one of the enemy's; or, by improving your situation, obtain a compensation for the loss. Examine which will be the best, when you can take a piece two or more ways. If



your antagonist can take the man in return, take it with that man which is of the least value. To exchange man for man, occasionally, is good play, or even to exchange a queen for a pawn, when this pawn would prevent you from giving mate, or to exchange man for man, when the enemy's man thus taken is one particularly in action.

Guard your men sufficiently; and if one doubly guarded of the enemy's be exposed to a guarded man of yours, let yours be trebly guarded. The more valuable men should be guarded by those of inferior worth; for, if your opponent guard his inferior piece by another inferior piece, you cannot employ your better piece to take your enemy's, as it would be lost. A far advanced pawn should be well guarded, for it is often indispensable to a check-mate, and may make a queen.

Castling is not always advantageous, as from the confined situation in which it places the king, it sometimes (particularly when the adversary has his knights in play) prevents his escaping out of check. It is, however, possible to retain the power of doing so, and keep the requisite pawns in their places. For as long as you have it in your power to castle, your opponent will be at a loss on which side to direct his attack; when he has decided, and brought his main strength to bear on one side, you can frustrate his design by castling on the other. It is not always good play not to stir the three pawns in front of the king that has castled; for liberty of moving may be necessary to get the king out of check. Crowd not your men too much together, as this restrains their movements. A man that cannot move is often worse than lost, by standing in the way. Endeavor to crowd your antagonist's game, in which you may succeed, if he bring out his pieces too early, by driving them back with your pawns. Endeavor to open your game by exchanging men in those parts where you want room, if you get unintentionally crowded.

Never make a move without examining whether you be endangered by the last move of your antagonist; nor with-

out calculating whether it will allow your enemy to harm you by his next. Beware of your enemy's knights, as they command different squares at once in a peculiar way. If a knight command the square of a queen or rook, at the same time that he gives check, the piece must be lost unless the knight can be taken; to avoid this, which is called forking, when a knight is near, a good piece should never be kept on a square of the same color as that occupied by your king. Do not let an enemy's pawn attack two of your pieces at once. Beware of two, and still more of three pieces, that manifest a design on the same square. Block up the way to such square by one of your pawns or a guarded piece. Your queen should never stand before your king, as, in such a situation, she may be lost, by a guarded rook being brought in her front.

#### STALE-MATE.

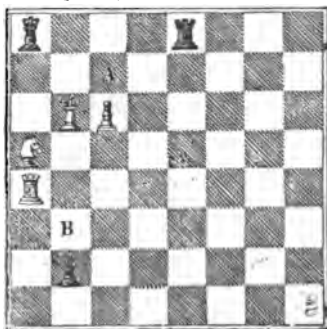
We have already stated, that if you have no pawn or piece, except the king, on the board, that you can move consistently with the laws of chess, and, at the same time, if your king, not being already in check, cannot move without going into check, a stale-mate ensues, and the game is drawn, being won by neither party.

#### CURIOUS PROBLEMS.

No. 1.

*White offers to give check-mate in two moves.*

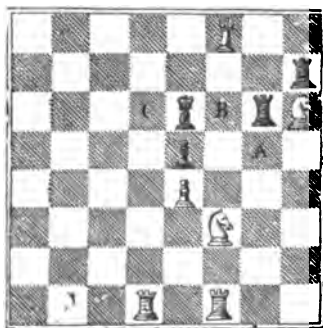
It affords us gratification to be enabled to lay before our readers the following few diagrams, which we have personally proved, from a very old and scarce Spanish author, Damiano, the earliest practical writer on chess, with the accompanying explanations, translated from the original, expressly for this work.



White's first move will be the pawn to A, and if Black then check with the rook, White will cover by his knight, and, in so doing check-mate the Black king with the castle. If Black, after White has moved his pawn as above, place his castle in C, White will make his pawn a queen, and so check-mate the adversary. If, in the first instance, instead of moving his rook, Black prefers queening the pawn, and,

## No. 2.

*White undertakes to mate in three moves.*



in so doing, giving check, White interposes his knight on B, and thus opens mate for the rook.

White checks by playing the knight to the square marked A. Black is compelled to take the knight with his castle. White then checks with his castle at square B. Black king takes the rook, and is check-mated by White moving his other rook to C.

## No. 4.

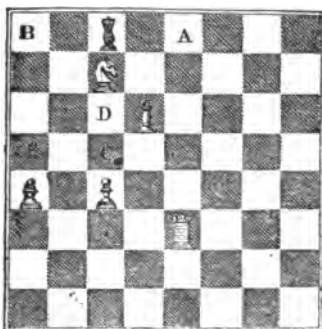
*White undertakes to check-mate with the pawn, in four moves.*



To effect this, White's first move is the king to A. His second, the bishop to B. His third, the bishop to C. And on the fourth, he check-mates, by placing the pawn on D. Black throughout having no choice, does not require to have his moves specified.

## No. 4.

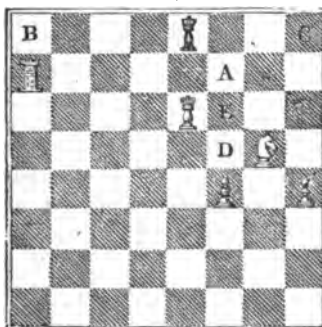
*White check-mates with his rook's pawn, in five moves.*



First. White checks with his rook on A ; he then moves the same piece to B. Next, check is given with the pawn on C. Again on D. And mate with the other pawn on E.

## No. 5.

*White to mate with a pawn in six moves.*



White's first move is the knight to A. His second, check with the rook on B. His third with the same on C. Fourthly, he checks with the pawn on D. Fifthly, with the same pawn on E. And, on the next move, check-mate will be given by the other pawn.

## No. 6.

*White will give check-mate in seven moves.*



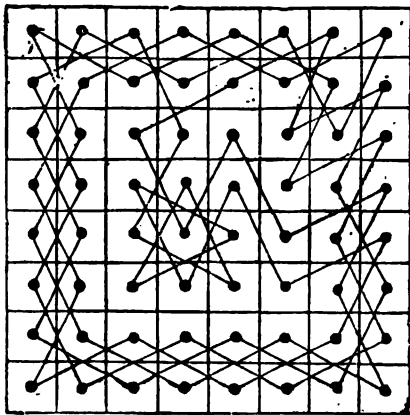
With the right-hand knight White checks on A. The other knight is next moved to B, and then White checks on C. On the fourth move, the White king plays to D. Check is given with the left hand pawn on E. Again with the same on F. And then the fatal check-mate must, of necessity follow from the other pawn.

### MOVING THE KNIGHT OVER ALL THE SQUARES ALTERNATELY.

The problem respecting the placing the knight on any given square, and moving him from that square to any house on the board, has not been thought unworthy the attention of the first mathematicians. Euler, Ozanam, De Montmart, De Moivre, De Majron, and others, have all given methods by which this feat might be accomplished. It was reserved however, for the present century to lay this down on a general plan; and the only English writer who has noticed this, is Mr. George Walker, in his "Treatise on Chess." The plan is this:—Let the knight be placed on any square, and move him from square to square on the principle of always playing him to that point, from which, in actual play, he would command the fewest other squares. Observing, that in reckoning the squares commanded by him, you must omit such as he has already covered. If, too, there are two squares, on both of which his powers would be equal, you may move him to either. Try this on the board with some counters or wafers, placing one on every square; and, when you clearly understand it, you may astonish your friends by

inviting them to station the knight on any square they like, and engaging to play him, from that square, over the remaining sixty-three in sixty-three moves. When the Automaton Chess-player was last exhibited in England, this was made part of the wonders he accomplished, though as the above plan was not then known here, he could not adopt it, but used something like the method laid down by Euler, and which we subjoin.

Our young Chess - player's instructor in the game will show him that as this is a re-entering series of numbers, or interminable route, it does not matter on which of the squares the



EULER'S METHOD.

knight is placed at starting; as, by acquiring the plan by heart, which is soon done, he can play him over all the squares from any given point, his last square being at the distance of a knight's move from his first. It is obvious that this route may be varied many ways, and we have often amused ourselves by trying to work it on a slate.



### *DEAF AND DUMB ALPHABET.*

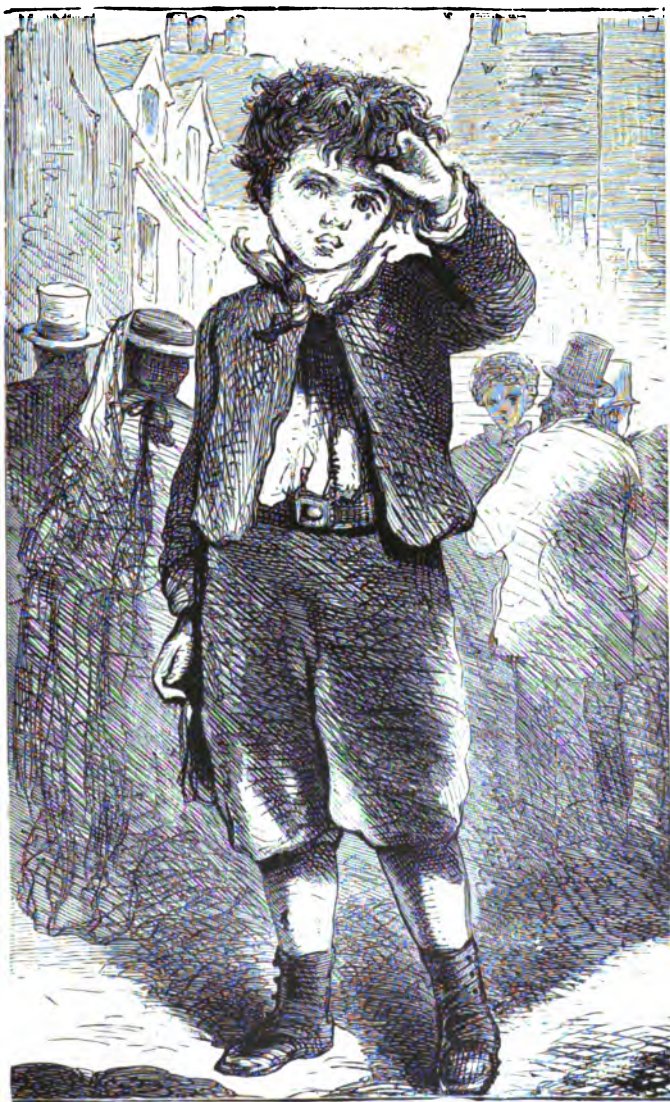
Though now grown old, she had a golden joy ;  
 Her dim eye brightened oft, to see her boy—  
 Albeit by heaven deprived of speech and hearing—  
     Throw by his homely toy,  
 And tell his love in a manner so endearing  
 Upon his nimble fingers, that she thought  
 Him more endowed than those bereft of naught.

The art of teaching those who are deaf and dumb a mode of comprehending whatever it may be desirous to convey to their minds, and of expressing their own wants and ideas to their more favored fellow creatures, is one of the greatest triumphs that humanity can boast.

It has the great advantage of being remarkably simple; so that a mother, brother, sister, or school-fellow, by a little perseverance, may give the deaf and dumb youth the means of communicating his wishes on all occasions. Our limits will not allow us to enter into any details, beyond the acquirement of the Alphabet, to which we add an engraving; showing the position of the hands to express each letter.

#### THE ALPHABET.

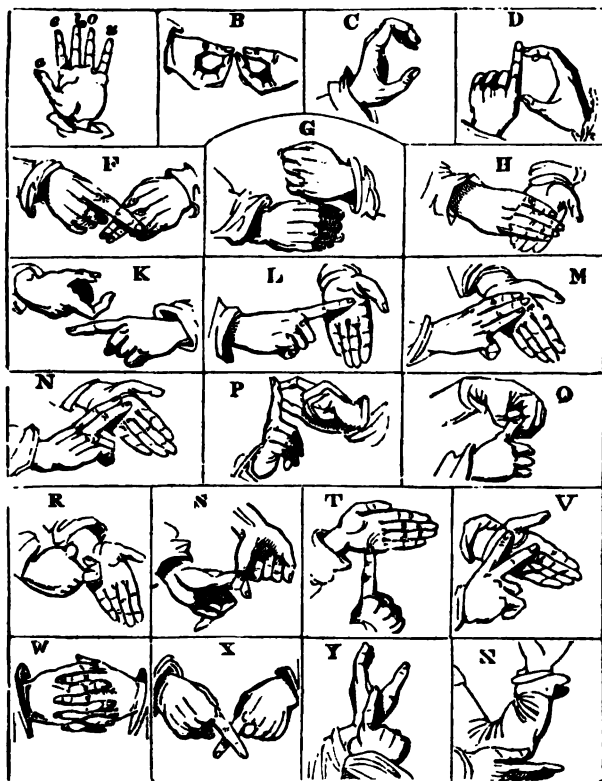
*A, E, I, O, U.* The vowels *a, e, i, o, and u*, are expressed by touching with the fore-finger of the right hand, the thumb, or one of the fingers of the left, according to the letter required to be expressed.







*A* is made by touching the top of the thumb; *e*, by touching that of the fore-finger; *i*, by touching that of the middle



finger; *o*, by touching that of the ring or fourth finger; and *u*, by touching that of the little finger.

*B.* Join the fore-finger and thumb of each hand, and place the backs of the two fore-finger nails together.

*C.* Curve the fingers and thumb towards each other, so as to resemble as much as possible the shape of the letter.

*D.* Curve the fingers and thumb of the right hand, but not quite so much as for *C*, and place the tops of the fore-finger and thumb against the side of the fore-finger of the left hand, which is to be kept straight.

*F.* Place the fore-finger of one hand across the back of the first two fingers of the other.

*G* and *J.* Clench the hands, and place one fist upon the other.

*H.* Draw the palm of one hand across the palm and fingers of the other, beginning near the ball of the thumb, and going along the hands to the tips of the fingers, precisely as if you were brushing something off the palm of one hand with the other.

*K.* Curve the fore-finger towards the thumb, and place the second joint of the fore-finger so curved against the back of the second joint of the fore-finger of the other hand.

*L.* Lay the fore-finger of the right hand straight upon the palm of the left.

*M.* Lay the three first fingers of the right hand upon the palm of the left.

*N.* Lay the two first fingers of the right hand upon the palm of the left.

*P.* Bend the thumb and fore-finger as for *D*, only make a lesser curve, and place the tops of the thumb and fore-finger to the two first joints of the fore-finger of the other hand.

*Q.* Place the tops of the fore-finger and thumb together; curve the fore-finger of the other hand, and place it on the inside of the fore-finger and thumb, precisely where they touch each other.

*R.* Curve the fore-finger of the right hand, and place it on the palm of the left.

*S.* Curve the little fingers of each hand, and hitch them together.

*T.* Place the top of the fore-finger of the right hand

against the lower edge of the left hand, between the little finger and the wrist.

V. This letter is made nearly as *N*, with this difference only that for *V*, the two fore-fingers of the right hand are placed apart, upon the palm of the left, instead of close together, as in the case for *N*.

W. Join the hands, with the fingers of one between those of the other.

X. Cross the two fore-fingers at the second joint.

Y. Place the fore-finger of the right hand between the thumb and fore-finger of the left, which must both be extended.

Z. Raise one hand towards the face, and place the palm of the other under the elbow of the arm which is so elevated.

It is usual to mark the conclusion of each word by snapping the middle finger and thumb of the right hand: this, it may readily be imagined, renders the dumb language much more intelligible.

*Numbers* are counted by the fingers in the most simple way; one finger held up, signifies 1; two fingers, 2; the open hand, 5; the two hands, 10, etc.





### *CROQUET.*

As a lawn game, in which both sexes can equally join, Croquet is deservedly popular. It is not necessary to say anything as to the origin of Croquet, as it is probably only a modern adaptation of the old game of Pall Mall, which was a fashionable amusement in the days of Charles the Second, and which probably gave its name to the famous street of club-houses at the West-end of London. As to the person who re-introduced it or re-named it, nothing is known, and it seems waste of labor now to inquire. A good deal of ingenuity has been displayed by various writers, with but small result, as to the author of the modern game; but whether it was invented without reference to the older game, or simply adapted, appears idle now to discuss. Suffice it that Croquet (pronounced krokay) made its appearance about a dozen years ago, and at once became fashionable.

As universally played, Croquet requires a level piece of turf or well rolled gravel, and a set of implements. These

consist of eight mallets, eight wooden balls, ten iron hoops or arches, a wooden turning-peg, a starting-peg, and a clip or marker for each player. The clips are not, however, indispensable, as the game can be played without them by all who are attentive to the last hoop through which the ball has been struck.

Croquet is played by two or more persons, who endeavor to strike the wooden balls through the series of arches, or hoops, arranged on the ground according to some particular design. He who first succeeds in passing his ball through all the hoops in regular succession wins the game.

But in order to fully acquaint my readers with the nature and peculiarities of this charming game, I must go somewhat further into detail.

Well, then, I suppose you to have purchased your set of Croquet implements; the next thing is to know how to play with them. You will see that the eight balls are variously colored; generally thus:—

- |            |            |
|------------|------------|
| 1. BLUE.   | 5. BROWN.  |
| 2. PINK.   | 6. ORANGE. |
| 3. BLACK.  | 7. GREEN.  |
| 4. YELLOW. | 8. RED.    |

The colors on the balls govern the order in which the players follow each other in the game. The mallets have usually rings of color to correspond with the balls. This also is to assist the players, and prevent confusion. The clips have likewise spots of color the same as the balls; and the iron hoops are ordinarily painted white, for the better seeing of them in the dusk of evening.

These preliminaries arranged, the players, when there are more than four, divide themselves into sides—say four on a side—and choose a captain for each side. They then place the hoops in the ground, according to some regular plan, with the starting-peg at one end and the turning-peg at the other.

In the Eglinton game a bell is suspended in the centre, from two hoops set crosswise; and a tunnel is set up on either side, instead of hoops. It is then necessary that the bell should be struck and rung by the ball before the centre cage can be fairly passed.

We now come to the technical terms used in Croquet. The following terms and the rules are those agreed to by a committee of good players:—

### TERMS USED IN CROQUET.

**IN ORDER.**—The term *in order* signifies the sequence of hoops, sticks, cage, etc., as described in the various plans above. The arrangement must be decided on before the game begins. Whichever plan is adopted, the game is won by the player or the side of players which first drives all the balls of its side in the right direction and *in order*, as arranged, up to the turning-stick, and back again until they touch the winning-stick.

**IN PLAY, IN HAND, DEAD.**—A ball is *in play* as soon as it has run the first hoop; it continues *in play* till it makes a roquet, when it is *in hand*. A ball *in hand* must take croquet, and can score no point till it has done so. Having taken croquet, it is again *in play*; but it continues *in hand* to the ball or balls it has croqueted for the remainder of its turn, unless it make another point. Having made another point, it is *in play* again to all the balls, as at the commencement of its turn. A ball is *dead* when it has run all its hoops *in order*, and has hit the winning-stick.

A ball is *wired* when it cannot effect the stroke desired on account of the leg of a hoop (wire) intervening.

**ROVER.**—A ball becomes a *rover* when it has *in order* passed the last hoop before the winning-stick.

The *Points* of the game are (a) running a hoop; or (b) a cage; or (c) hitting a stick, each *in order*.

(a) A hoop is run when a ball *in play* having passed through it in the right direction, in one or more strokes, and with or without hitting the hoop, a straight-edge applied

behind the hoop does not touch the ball. Hoops accidentally displaced from the perpendicular may be set upright at any time.

(b) In testing the running of the cage, which may be run in any direction, the straight-edge (*ex. gr.*, the handle of the mallet) is applied on the inner side of the two legs nearest the ball.

(c) A stick is hit when seen to move, or an audible noise is produced by the blow. The stick may be put upright at any time if accidentally displaced.

A player is not obliged to play for a point or roquet. He may, if he prefer it, place his ball where he likes, by a stroke of the mallet.

A *Roquet* is made when a player with his own ball hits another, however slightly, both being *in play*. It gives the privilege of a croquet from the hit ball, which may be either tight, loose, or rolling, and entitles the player to another stroke.

The Roquet can only be taken advantage of once in each turn from the same ball, unless another point is made. It follows that a second roquet, in one turn, without a point made in the interval, does not count; but it may be made for any purpose, such as cannoning, driving away, etc., the player's turn ending there, unless by the same stroke he makes a point, or roquets another ball, which he has not roqueted before during the turn, and since making a point.

A *Tight Croquet* is made by placing the ball of the player close to that roqueted; then fixing his own ball with his foot, he strikes, driving the other ball away, but keeping his own under his foot. If the ball slip from under the foot, the stroke following the croquet is forfeited.

A *Loose Croquet* may be made either (a) by placing the player's ball close to that roqueted, and striking the former in a line passing through the axis of each, in which plan the player's ball remains almost stationary, while the other flies forward, or (b) at any angle, so as to place the two in



such opposite positions as may be desired, and hence called a "splitting croquet." Where it is wished (c) to make a loose croquet with as little disturbance as possible of the player's ball, it is often called taking "two turns off" it, but in that case the latter must be made to move, however slightly, to the satisfaction of the two captains or their umpire.

A *Rolling Croquet* is effected by placing the two balls in the same way as in the loose croquet (a), but after the initial stroke is fairly made, the mallet follows the ball, and causes the two to roll nearly together to the positions aimed at.

*Spooning* is a pushing stroke, causing no noise as of a tap to be heard.

It is very difficult to define what separates the fair strokes from "the spoon." We believe the only way to avoid disputes on this score is to do away with any but the side stroke, and even with it, to forbid the approach of the hand nearer than eighteen inches to the head of the mallet, when spooning is almost impossible.

The following are the now generally accepted

#### LAWS OF CROQUET.

I. The rotation of play is to be decided by lot, and the captain gaining the toss takes either the dark or light balls, at his option, his opponent having the others, and each allotting the colors as he pleases. Blue then leads off, followed in rotation by the other colors, till his turn comes round again.

II. The first stroke of each ball is made by placing it anywhere not exceeding a mallet's length from the starting-stick, and striking it through the first hoop. If this point (see Definitions) be made, another stroke is allowed, but if it fail, the ball is taken off the ground till its next turn comes round.

III. After the first hoop is passed, the player of the ball running it can go on with his play so long as he succeeds

in either running a hoop or cage or hitting a stick, each *in order*, and with his ball *in play*, or makes a roquet on any ball *in play*. Having made roquet, he must take croquet before his next stroke.

When the turn comes round, it is optional for the player to "place" his ball, or to commence by playing either for a roquet or a point.

IV. If a player roquet a rover against the winning-stick, he cannot take croquet, as the other ball is dead, and he loses his next stroke.

V. A ball *in play*, driven through its proper hoop or cage, or hitting a stick *in order*, by any stroke, whether of the same side or that of its antagonist, counts that hoop, cage, or stick, even if it roll back through the hoop or cage; but in the latter case the running must be established to the satisfaction of the two captains or their umpire.

- (a) If a ball, after roqueting another, and before taking its croquet, run a hoop, such ball is not entitled to the point, as it is then "in hand."
- (b) If a ball, while passing through a hoop, roquet another before the former is entirely through, the hoop does not count, and the croquet must be taken. This point constantly calls for the decision of the umpire.
- (c) A ball driven back through a hoop the reverse way to which it is going, "in order," and resting under it, is not entitled to run that hoop, if a straight-edge applied in front of the hoop touch the ball.

VI. All strokes must be given by the player standing on one side of his ball. Either one or both hands may be used, but the nearest hand to the head of the mallet must be eighteen inches at least from it, except when the player is under five feet in height, when half an inch may be allowed for each inch in stature below that standard. The handle must not be grasped between the arm and the body.

VII. The side of the head of the mallet is not to be applied to the ball in striking it under any circumstances; and if so used, the stroke is forfeited, and any balls moved

are to be replaced to the satisfaction of the adverse captain. But either end of the head of the mallet may be used, whatever be the difference of shape between them.

VIII. If, when about to play, a player find his ball touching another, he may hit his own as hard or as soft as he likes, and then, being *in hand* to it, he may take a croquet off it.

IX. A rover (see Definitions) has the right of roqueting and croqueting any ball (whether partner or antagonist) only once during each turn, and of taking another stroke subsequently to each in succession; but having passed all the hoops, it has no point allowed for running one. It is subject, on the other hand, to be roqueted or croqueted by any other ball *in play*. If this cause it to strike the winning-stick, the ball is out of the game, and must be removed from the ground.

X. A ball struck beyond the limits of the ground must at once be replaced half a mallet's length within the edge, measured from the spot where it went off at right angles to the margin.

XI. Every player, on being appealed to, shall declare which is his next hoop *in order*; and, on the other hand, before playing, every player may demand from the captain of the opposite side which is his proper hoop *in order*; and should any dispute arise, it must be settled by the two captains or their umpire.

This is a game of skill, and does not depend upon memory. It is therefore far more agreeable to all parties that the trouble of remembering the score should be rendered as little burdensome as possible. Clips and indicators are sometimes used to denote the position of each ball, but in our opinion they are very troublesome, and do not answer so well as the above rule.

XII. The penalties of the game are as follows:

(a) If a player, in making a tight croquet, allow his ball to slip from under his foot, he loses his next stroke.

(b) If in taking *two turns off* a ball, he fail to move it, he loses his next stroke.

(c) If any ball when *in play* and rolling is stopped or touched either by the hand, foot, dress, or mallet, or by any other substance held by its player, or one of his own side, the player of that ball ceases to play for that turn. But if either of the above acts is done by one of the side opposed to that of the striker, he may at his option, either take the stroke again, or the game may proceed with the ball, or balls, left where it, or they, were stopped.

(d) If, in striking at his own ball, the player, either before or after the blow is actually given, hit another with his mallet, he loses his present turn, and the ball improperly hit is replaced to the satisfaction of the adverse captain.

(e) If a ball, not being hit sufficiently hard, is hit a second time, the stroke is forfeited, the balls are to be replaced to the satisfaction of the adverse captain, and the player loses his turn.

(f) If a player play out of his turn *in rotation* (see Law I), and the mistake is discovered before the next player has commenced, all benefit from any point or points so made is lost, and all balls hit are to be replaced, or left where they are struck, at the option of the adverse captain. But if the mistake is discovered after the next player has played his first stroke, the turn played in error must be allowed to stand.

(g) If a player in his proper turn play with the wrong ball, or if he croquet a ball which he is not entitled to croquet, he loses all benefit from that stroke; the ball or balls are replaced, and the turn is lost. Should the error not be discovered till he has made a second stroke, the player proceeds as if no mistake had been committed. At the end of the turn the balls are to be transposed from one position to the other, and in their next turn the players of each proceed in the same rotation as if no mistake had occurred.

(h) If a ball is not fairly hit, but, in the opinion of the captains or their umpire, is pushed or "spooned," all benefit from that stroke is lost, the ball must be replaced to the satisfaction of the adverse captain, and the player loses his turn.

(i) If, in taking aim, a ball is moved more than six inches it must be considered that the player has taken his stroke. But if the ball is moved less than six inches, the stroke may be taken again.

### PRACTICAL INSTRUCTIONS.

Hold your mallet firmly, yet easily, and be certain that you hit your ball, always endeavoring, when possible, to run your hoop. Help your partners whenever you can, and puzzle your opponents whenever there is a chance. In making the croquet, place your toe well on your own ball, with your heel on the ground; then strike your ball fairly, so as to cannon the other ball in the direction you wish it to take. It is important the rover should do all he can for his side. Always recollect that in making a roquet it is only necessary to reach the ball: and when you want to run a hoop that is not in a direct line with your ball, play behind the hoop, at an angle, so as to allow you to run the hoop when your turn comes round again. Good temper, tact, and attention are the best assistants to the young Croquet player.







*LA CROSSE.*

La Crosse is a game very popular among the Indian tribes of North America, and but lately introduced into England. It is an adaptation, probably, of our own Hockey; only, instead of the ball being hit away with a stick, it is caught up on a netted bat, and carried by the player. The game is sufficiently well explained in the following rules, which were drawn up by a committee of players, after consultation with a company of Indians brought over to England in the summer of 1867 :

## RULES OF LA CROSSE.

I. that the "Crosse" may be of any length to suit the player, but the woven network must not be bagged, nor of a greater width than one foot.

II. That the ball be of solid india-rubber, not more than seven nor less than six inches in circumference. It must be furnished by the challenging party.

III. That, when practicable, the goals shall be placed at not more than 250, or less than 150 yards apart, and that the ground be not more than 100, nor less than sixty yards wide; that the goals be upright posts seven feet apart, with a tape or bar across them, six feet from the ground.

IV. That the game be started by a ball being placed on the ground opposite the centre flag between two players on opposite sides, who shall "tussel" for the ball. This is called "facing."

V. When the ball goes out of bounds, it shall be thrown in by the player who first touches it with his crosse: when it goes behind goal without passing through goal, it shall be thrown out by one of the players on the side behind whose goal it has passed.

VI. That the ball shall not be hit or kicked.

VII. No player shall wear spiked soles.

VIII. That the ball must not be caught, thrown, or picked



up with the hand, except in the case of Rule IX.; but a ball coming in the air may be blocked or patted away with the hand to protect the face or body; otherwise it must not be touched.

IX. Goal-keepers may stop the ball in any way.

X. A goal is obtained when the ball is in any way whatever caused by a player on either side to pass between the goal-post and under the bar or tape, except when kicked by one of the attacking side.

XI. Players shall not hold each other, nor grasp an opponent's crosse; neither shall they deliberately trip or strike each other.

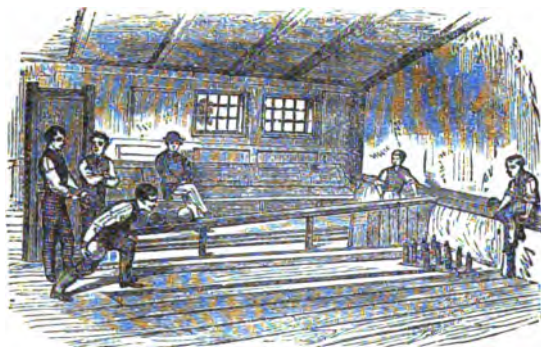
XII. After each game the players shall change goals, unless otherwise agreed.

XIII. A match shall be decided by a majority of goals won by either side during the time specified for play.

XIV. Twelve players shall constitute a full field.

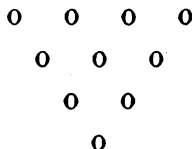
XV. No change of players shall be made after a match has commenced, except by reason of accident or injury during the match. When a match has been agreed on, and one side is deficient in the number of players, their opponents, at their option, may either limit their own side to the same number, or select men to fill up the complement.





### TEN-PINS.

This game is the old English sport of Long Bowls. It is played in an alley from twenty to thirty yards in length. At the end opposite the starting-place, ten skittles are placed in the following way:



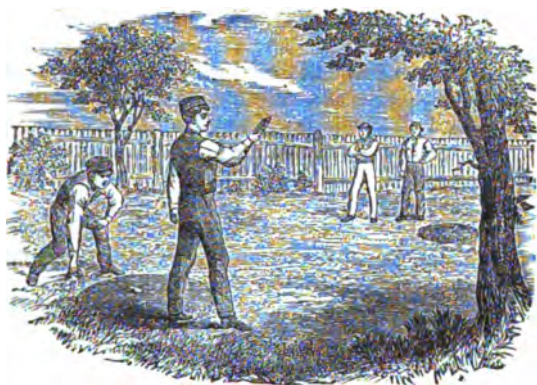
sufficient space being left between each pin to allow the ball to pass through. The skittles are usually set on a wooden floor, with the place of each marked by a metal plate, and just behind is a trough, or lower floor, filled with saw-dust, into which the spent ball falls. It is the business of the player to bowl down the skittles in one or more throws—taking a fresh ball for each throw; and he who succeeds in knocking them all down in the smallest number of bowls wins the game. Wooden balls of various sizes are used, the

smallest being about the dimensions of a Dutch cheese. The ball must be rolled along the floor, and not thrown, jerked, or pitched, with any degree of swiftness desired. The fastest balls are not always the best, however, as they are likely to pass through the pins without doing much execution. A boy, called the marker, sets up the fallen pins, calls out the number down, and returns the balls along a narrow trough, or groove, that runs sloping down the side of the alley. The game is marked in different ways: 6 points for a "floorer," which is when all the pins are overturned by a single bowl; 8 for an odd number of pins; 1 for each pin displaced, and so on, according to agreement.

#### BLACKTHORN.

Blackthorn is a very good game, but rather apt to be destructive to the clothes. A base is marked off at either end of the play-ground, leaving a space in the middle. One of the players volunteers for, or is chosen, "Fox," and takes up his position in the middle between the two bases; the rest run across from base to base, while he endeavors to catch and hold them. If he can hold one while he can count ten, it is considered a fair catch, and the prisoner becomes fox too, and assists in the capture of more—all of whom, as soon as caught, go to swell the number of foxes. Thus it will be seen that the game continually increases in life and interest up to the final capture, each capture making the passage across more hazardous.

As a general rule, the worst runners and weakest players are caught first, and the better ones only succumb one by one, overwhelmed by numbers. With so many enemies, speed alone must soon give in; but speed and weight combined will often break through a whole crowd of opponents.



### QUOITS.

There is little to describe in this athletic game; though it is very amusing nevertheless. It is played with iron rings or hollow discs, and the object of each player is to pitch his quoit as near as possible to the hob, which is an iron pin set straight in the ground; and he who succeeds in getting nearest to the hob in a certain number of throws wins the game. An iron is set in the earth at each end of the selected ground, at a distance of eighteen, or twenty, or more yards, according to previous arrangement. The game then proceeds as follows (I quote Strutt, whose "Sports and Pastimes" is the recognized authority on all *old* English games):—"Two or more persons, who are to contend for the victory, stand at one of the iron marks, and throw an equal number of quoits to the other, and the nearest of them to the hob are reckoned towards the game. But this is not always the case; for instance, if a quoit belonging to A lie nearest to the hob, and a quoit belonging to B the second, A can claim but one toward the game, though all his other quoits lie nearer to the mark than all the other quoits of B,

because one quoit of B being the second nearest to the hob, *cuts out*, as it is called, all behind it; if no such quoit had interfered, then A would have reckoned all his quoits as one each. Having cast all their quoits, the candidates walk to the opposite side, and determine the state of the play: then taking their stand there, they throw their quoits back again, and continue to do so alternately as long as the game remains undecided."

#### PITCHING AT THE CORK.

This game is also played with the quoit, generally at fairs, races, and such-like meetings. A cork is placed on the ground, and a small sum is put upon it, either a little piece of silver, a copper coin, or buttons. A line is drawn on the ground at a convenient distance from the cork, on which the players stand. Each player is provided with two quoits; he who plays first throws one of his quoits as near to the cork as he can, and with his second he endeavors to hit the cork, and drive it away, in such a manner that the money or whatever else was on the top of the cork, on falling to the ground, shall be nearer to the one or other of his quoits than to the cork. If he succeed, the stake belongs to him—if he do not, a second player throws his quoits, and endeavors to accomplish the feat in which his predecessor failed.





### RIDING.

This exercise renders the body flexible, and gives it grace and ease. It is best to accustom one's self to this exercise in youth, when the body bends itself more easily to all the movements required. The joints have then a suppleness and energy which at a later time they lose, and consequently one is able to execute better, and with less danger, the several exercises which come under the head of Equitation.

It is as well to explain at first by what means man makes known to the horse which he mounts his wishes, and to force him to obey them. These means, which are called helps or aids in *stable parlance*, consist in the proper use by the rider of his legs, the *spurs* affixed to the heels of his boots, and of the bridle, the *reins* of which are attached to a *bit*, which is held in the mouth of the horse. The employment of these aids to horsemanship enables the rider to govern all the movements of the horse on which he rides. For instance, the rider wishing to pass from a standstill into motion, informs the horse of his wish by pressing him a little with his legs, and by progressively raising the hand which holds the

bridle. These two movements force the horse to raise his head, and putting his body in motion, he prepares to execute the order which has been transmitted to him. This is called *gathering up your horse*. In order to walk straight ahead, the rider lowers his hand, and consequently the reins cease to pull the bit in the mouth of the horse, which, finding himself not held back, naturally walks. On feeling himself pressed and driven on by the knees and legs of the rider, which act simultaneously with the hand, he again moves quickly. But if, through not being well trained, or by caprice, the horse misunderstands the rider, and refuses to advance, then the legs of the rider are carried behind the girths, and he applies the spurs to the flanks of the animal, who, in order to relieve himself from the pain, hastens forward. If the rider wishes to pass from a walk into a trot, or from a trot into a gallop, the bridle is still more loosely held, which diminishes the pull of the bit in the horse's mouth, and by a sharp action of the spurs the rider informs his horse that he wishes to go at a quicker pace. If, on the contrary, the rider wishes to lessen his speed or stop, he pulls in the reins tightly toward him, and this movement causes the bit to pull at the horse's mouth ; and in order to escape from the pain, the animal slackens his speed, and stops altogether if the pressure on the bit continues. But, as in this movement, the horse can turn his body crosswise, the rider keeps his legs against the body of the horse, which, from fear of the spurs, does not dare to throw his legs out either to the right or left. If the rider wishes to turn to the right, he holds his hand on the side, which causes the bit to press harder on one side of the horse's mouth than on the other ; and he naturally gives way this side to escape the pain. He therefore turns his head in this direction, and the rider hastens his movements by applying the spur to this side. The left-turn, the half-turn, and the circle, etc., are executed by the employment of the same means, modified according to the requirements, there being always a perfect accord between the movements of the legs and those of the

hand. Lastly, the horse is backed by the rider pulling the reins toward himself hard, which causes a pressure of the bit on the mouth of the animal, and which therefore backs in an opposite direction to the action of the bit.

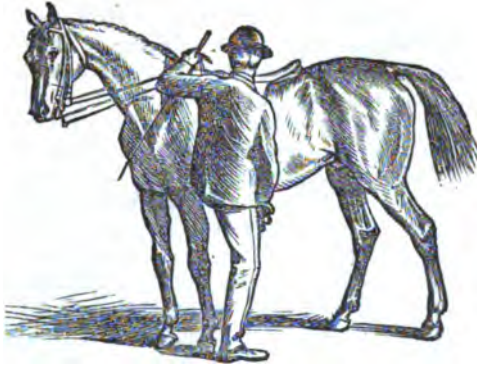


Let us now see whether we cannot teach you how to ride. Pupils in horsemanship generally take their first lessons on quiet or rather old horses. After the amateur has mounted his horse, he is put on the road to perfect horsemanship. Usually there are several together, and a well-experienced horseman takes his place at the head of them, and the others have only to follow him, practising themselves in sitting their horses well, and the riding-master puts them right every time it is necessary. Afterward, when the pupils have familiarized themselves with the posture, and have acquired a certain habit of riding their horses, each one of them becomes guide in his turn. All the first exercises are usually practised without stirrups, and with the aid of a snaffle-bridle, which is less painful than the ordinary bridle to the mouth of the



horse. At his first essay, the pupil does not run the risk of making his horse turn and back ; but holds his reins in a manner which compels the horse to go forward, and at the same time keeps him firm in his seat on the animal's back. When the young horseman has acquired some confidence on his horse, he can pass into a trot, and then into a gallop. Once arrived at the power of being able to easily guide his horse with his legs and hand, so as to make it go at all paces and to stop it, he is taught, as we have explained, the action of the bit and the reins, the manner of producing this action by the movement of the hand, the movements of the legs, and lastly, the accordance which there should be between the hand, the bridle, and the reins, between all the movements of the rider and his horse.

The side of the horse from which the rider mounts and dismounts is generally the left, but it is as well to accustom one's self to mount and dismount on both sides, so as not to be embarrassed when unforeseen circumstances oblige you to mount or dismount on the right side. In order to mount a horse, seize the upper part of the reins with the right hand, raise them until you feel the reins are pretty tight, then pass the little finger of the left hand between the two reins, the three other fingers on the right rein, and the thumb on the left; then lay hold as well as you are able, with the left hand, of the horse's mane, and in this position the left hand should be ready to check the horse, should he commence to start. Then raise the left knee, and put the left foot in the stirrup, put the right hand on the saddle, raise yourself up by a spring until your right leg is on a level with your left, then pass the right leg over the saddle, and place the foot in the stirrup, drawing the right hand away from the saddle, Then separate the reins,—hold one in each hand, the upper part of each rein being held steady by the pressure of the thumb. This is the safest way for a beginner to hold the reins; but he will gradually acquire the more masterly way of holding them, and which he will easily understand by noticing the way in which an experienced horseman holds them.



The rider should be seated perpendicularly on the saddle, the shoulders square, the head upright, without stiffness, the chest expanded, the hips firmly planted, the knees pressed against the saddle, the point of the foot being lower than the heel.

#### DRIVING.

With regard to the *harness* necessary for various kinds of carriage horses, little need be said; very slight acquaintance with a horse in harness will familiarize your mind with the bridle, blinkers, bit, reins, traces, crupper, girths, collar, and pad. These are all provided by the saddler, ready for use, and need no particular description. But it is well that every driver should know how to put on the harness to a horse, as occasions may arise when a want of such knowledge is of great importance—as in a breakdown, for instance, when the proper adjustment of the several straps will enable you to do that for yourself which your groom or stableman does before starting.

It is not necessary, either, that I should enlarge upon the various kinds of horses and carriages in common use upon the public roads; sufficient if I show you how you may safely and easily drive a single horse in a wagon, and a pair in a phaeton or barouche.

## DRIVING A SINGLE HORSE.

We will suppose that you are driving a single horse. Mount easily into your seat, which is at the right-hand side of the vehicle, and take the reins and whip in your hands. Place your feet firmly and easily on the footboard, and keep your legs straight, but not too stiff. Then give the horse his head; and encourage him by your voice, or a gentle fillip with the whip. Hold the reins rather tightly, and when you want the horse to turn to the right, *pull the right rein*; when he has to go to the left, *pull the left rein*. Both hands will be brought into use, but for a quiet horse you will find that you will need but little whip; and that one hand will be sufficient for the reins. Avoid jerking your horse from side to side, and, when he is going easily, let him go at his own pace. A gentle hand will do more than violence or unnecessary exertion.

In *passing* streets that lead into the main road, go slowly, and always keep a good look-out *before you*, without taking heed of what is behind. If anything in front causes you to slacken your pace, raise your whip, so that the driver of a vehicle behind you may have notice also to go less rapidly. Avoid all sharp turnings, and remember the rule of the road—*keep to the right*.

In *stopping*, accustom your horse to obey a slight pull of the reins, both together, *aided by your voice*, which you will generally find as efficient as whip or rein. Do not allow your horse to canter or gallop; a trot is the proper pace for a horse that pulls a load after him. Walk him up hill, and hold him well in hand in going down hill. Avoid too rapid a pace; for though the temptation to drive fast is very great, fast driving is the cause of most road accidents, especially with young and inexperienced drivers.

If your horse should show an inclination to *balk*—that is, to stand still and disobey the whip—let him stand for a while, and then gently encourage him with your voice, or get some bystander to lead him gently by the head. If he *bolt*, take the reins, crossed, short in your hands, and hold



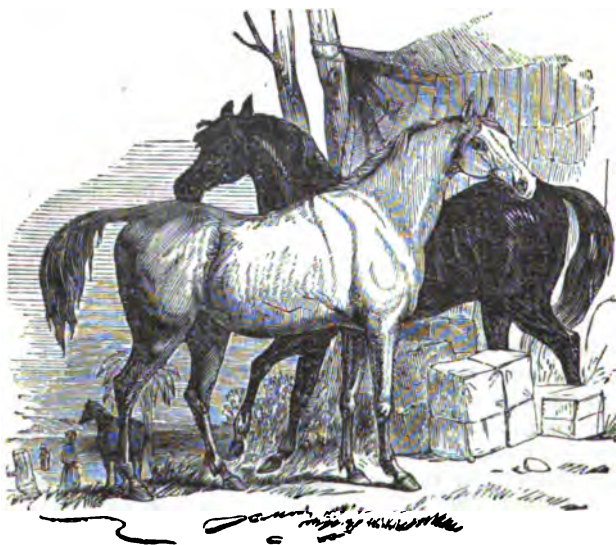


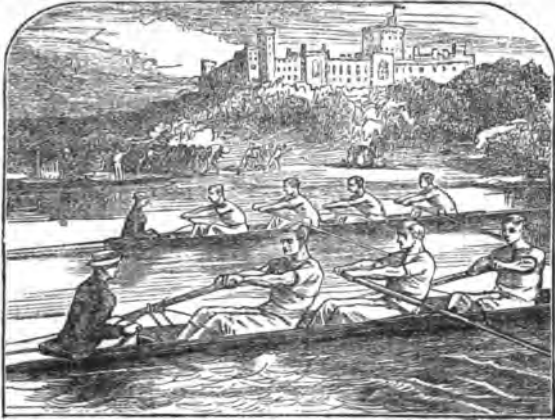
them tightly, keeping your seat firmly, and at the same time *saw* the bit in the horse's mouth, by quickly pulling each rein alternately with a decided tug. The horse, even when he runs away, will generally obey the rein sufficiently to avoid obstacles. Do not be alarmed, but be prepared for emergencies. In a little while your steed will slacken his pace, when a sharp corrective with the whip will do him good, and teach him that you are master, not he. Horses are very knowing animals, and they soon discover the character of their driver. If you are determined, they will submit; if you are nervous, they will rebel. Either they or you must govern; and if you have not the moral or physical power to control a young, spirited horse, do not attempt to drive it. Patience and decision are the grand arguments with a horse. Never over-drive him, and always see that he is properly fed. Do not be content with the assurance of the groom at an inn, that "Your horse is all right, sir; I'll see that he has his feed;" see to that yourself, and before you have your own dinner see that your horse has his corn, and that he is carefully rubbed down with a dry cloth—not washed. The stable at home is the proper place for the washing operation.

*Ill-tempered horses* must be coaxed and conquered. For such, a "ring bit" or a "post bit" is necessary sometimes. Remember that a dead pull is of little use with such horses. If the horse stumbles or falls, pull him up shortly, and give him a smart fillip with the whip. He will generally get up of himself. A horse that is apt to stumble must be kept well in hand, and also be kept active with whip and reins, so that he may know you are master. A *kicking horse* should have a kicking strap; and when he shows any intention to indulge his propensity, give him a sharp reminder with the whip over the head and back. A *shying horse* must be coaxed and soothed—not whipped. An experienced driver will endeavor to encourage his horse by his voice and rein rather than with the whip. Horses are very much like men and women: it is easier to lead than to drive them.

## DRIVING A PAIR.

Now, strange as it may sound to amateur drivers, it is easier to drive a pair of horses than it is to properly drive one. But nerve and steadiness are absolutely requisite. The same general rules in driving, with regard to your seat and the method of guiding them, apply to a pair of horses as to a single horse. But somewhat greater attention is required to keep them together.





### *ROWING.*

#### ADVANTAGES OF ROWING.

Among outdoor recreations conducive at once to the promotion of strength and enjoyment, rowing takes a foremost place. Few manly sports are more exhilarating, or more fitted to nerve and brace together every muscle and sinew of the body. To the chest and lungs the exercise is particularly beneficial; and youths who exhibit a tendency to contraction of the chest, or whose time is much occupied by sedentary studies, should be encouraged to make rowing a favorite amusement. With every stroke of the oar the organs of breathing, on which the health so greatly depends, are brought into fuller and freer play. The muscles of the arms and the sinews of the legs also receive a corresponding benefit; and it is well known that the students at our public schools and colleges owe much of that strength and vigor for which they are generally remarkable, to their assiduous practice of this favorite recreation.

Rowing has other advantages, as a sport, apart from its



influence on the strength of the constitution, and its promotion of the development of a manly form. It can be followed by one, or by many together, with almost equal enjoyment. Boats of all sizes are provided on most of our canals, lakes, and rivers, in which parties of from two to eight friends can take this invigorating exercise together, or if the number be larger, can indulge in manly rivalry as to science, skill, and strength, by pitting one boat's crew against another. In competitions of this kind only somewhat skilled or experienced rowers should indulge, and I would earnestly recommend the learner never to attempt to take part in "a race" until he has acquired the command of his oar, and the habit of pulling a good steady stroke. Hasty, unsteady pulling at the outset of his career as an oarsman will go far to spoil his future "style," which is an object of great consideration to every practised hand.

Rowing, as I have said, may be practised and enjoyed by the man or youth who has not immediately before him the opportunity of friendly companionship. But to take a boat single-handed requires some practice, and therefore should never be attempted by the learner at his first start. When, however, he has acquired sufficient experience to handle "a pair of sculls," and to manage a boat by himself, nothing can be more delightful than an occasional pull up or down some quiet stream; if on a river, putting out the strength while rowing against the tide, or suffering the boat to glide along down the water, by the aid of little exertion from the oarsman, if the tide be in his favor. Thus health, strength, a taste for the beauties of nature—sky and landscape, meadow and field—and that reflection and meditation in which it is good even for youth to occasionally indulge, may each be fostered and drawn forth by what all who have been initiated into it regard as a delightful sport.

#### THE BOAT.

Having said thus much in favor of rowing as an exercise, and the advantages peculiarly attached to it, we will pro-

ceed to give the learner some description of the boat, and the technical names by which its several parts and appendages are known.

The boat in which it is advisable for the inexperienced rower to attempt to learn, and to which we shall therefore first direct his attention, is what is called the *pair-oared boat*. This boat is, in its main features, like every other description of boat.

The bow is the head of the boat. The sides here meet at a sharp angle, by which the boat is enabled with greater facility to cut through the water. The small points projecting upwards from the sides of the boat, two on each side, are termed the row-locks. In these the oars are placed, and by means of them the rowers obtain the purchase necessary to enable them to propel the boat. They are formed of flat pieces of wood, generally oak or ash, and the one nearest the rower, when he is seated in position with his oar in the row-lock, is termed the thowl-pin, while the other is known by the name of the stopper. Against the thowl-pin the oar is pushed back and pulled, while the other, as its name implies, serves the purpose of staying the oar from slipping forward after the rower has made his stroke. To these two small pieces of wood the rower is thus principally indebted for his power of control over the motions of the boat. The seats for the rowers are called the "thwarts." They stretch across from side to side of the boat, a few inches below its edge, or, as it is technically termed, the wall. At the bottom of the boat, in front of the rower, a board is fixed, against which he places his feet. This board, called the "stretcher," is generally movable at will, according to the height of the person seated, or, to speak more clearly, according to the length of his legs. When properly adjusted, the foot-board is of considerable service in enabling him to keep his body in proper position, and, by the purchase given to his movements, assisting the power of his stroke. At the stern of the boat is a seat for the coxswain or steersman, who holds the lines of the rudder in his hands; although,

when two rowers of any experience are engaged, it is by no means necessary that any one should steer, provided that the oarsmen keep sufficient look-out occasionally to see where they are going. As the position of the rowers is necessarily with their backs to the head of the boat, it is of advantage to learners when they can obtain some one to steer for them, and thus give their whole attention to their stroke, leaving the guidance of the boat in the steersman's hands. The end of the boat is called the stern, and here is placed the rudder, which, when one person is steering, directs by its movements the course of the boat. He takes one of the lines attached to the rudder in each hand, and by pulling either the left or the right line, a corresponding turn is given the boat. When no one steers, the course is guided or changed at will by pulling either one or other of the oars alone, according to the direction in which it is desired to proceed. If it be necessary to turn the boat completely round, one of the oarsmen puts his oar into position to "back water," while the other pulls in the usual way. "Backing water" will be explained when we come to our directions for rowing.

#### SCULLS AND OARS.

It is now necessary that I should give some description of the instruments used in propelling the boat. These are either oars or sculls. Sculls are a small description of oar, and are intended to be pulled with one hand only, the rower taking a pair, one in each hand. But in learning it is advisable to commence with a single scull, which is lighter, and therefore more easily managed than the oar. After a little practice with the scull, the beginner will be able to manage the oar with ease. The oar consists of three parts, which are known as the handle, the loom, and the blade. The handle is rounded, and is long enough to be grasped by both hands. The loom is square, and extends from the handle to what is called the button of the oar. The button is a piece of leather fixed on the oar at the distance of about

one third of its length, and rests against the thowl-pin when the oar is placed in the row-lock. Its object is to keep the oar as nearly as possible in one position in the row-lock, and prevent its slipping through. At the point of the oar where the button is fixed commences the blade, which is long and broad, thick at the commencement near the handle, and becoming thinner toward the end.

#### DIRECTIONS FOR SCULLING.

In commencing the practice of boating, I have already recommended the learner to begin by the use of a single scull,—two persons sculling at the same time—deferring the



PAIR-OARED OUTRIGGER GIG.

attempt to manage an oar until he has had some little experience with the lighter instrument. The boat chosen should be a pair-oared boat, of moderate size—neither so heavy as to be unmanageable by inexperienced hands, nor so light as to involve the danger of being upset. The beginner, having seated himself, and adjusted the footboard, or “stretcher,” at the distance most convenient, placing his feet firmly against it, should take the scull by the handle,

and place it in the row-lock, with the button resting against the thowl-pin. The hand farthest from the side of the boat over which the scull is passed should be placed upon the handle near the end, grasping it firmly. The thumb should be kept, with the fingers, above the handle of the scull. The other hand should grasp the scull a little lower down, but with a somewhat more free and relaxed hold, as with this hand the movement called "feathering" is performed. The arms should now be thrust forward in straight position, and the body then bent in the same direction, though without assuming an ungraceful stoop. If the hands be now raised, the blade of the scull will drop into the water, which should be done without splashing, and only so far that the water may cover the blade. Nothing is gained by dipping the scull or oar in to a great depth; on the contrary, the rower's toil is increased, while the speed of the boat is not accelerated, and the learner is far more likely to "catch a crab." This term is used when the rower loses command over his oar or scull, and cannot draw it through the water, in which case he should immediately throw the oar forward out of the row-lock by lifting it over the stopper. "Catching a crab" is sometimes sufficient to upset a boat, if it happen to be a very light one, or outrigger.

Having dipped the scull into the water in the way described, the body is brought back till it becomes upright again, the hands following it. This motion has the effect of impelling the scull through the water, and in its passage the blade should be kept at the same depth as when first dipped. Just before bringing the scull or oar out of the water, a turn of the wrists should be given to the hand nearest the blade, the knuckles being brought toward the chest. This movement is called "feathering," and has the effect of bringing the oar cleanly out, the water glancing from the blade. The original position should then be resumed, the arms and the body thrown forward again, and so with every stroke. The learner should not attempt, at the outset of his boating experience, to take his strokes quickly, but rather endeavor to

acquire the habit of making a long and steady pull. After practising a little with the scull, the learner will be able to manage an oar with ease; and he may next proceed to take a pair of sculls. In pulling a pair, the movements are of course effected in the same way as with one; but one hand should be kept slightly above the other, that they may not be knocked together.

### SCULLING WITH A PAIR OF SCULLS.

Enter the boat carefully, and take your place amidships in such a way as not to throw the boat out of balance. Then sit with ease, with your feet well planted on the stretcher, which should not be so far from the seat as to fully extend your legs. You can move the stretcher nearer or farther at pleasure. Then take the sculls—I am supposing that you are alone in a good, wide, and rather heavy boat—and grasp

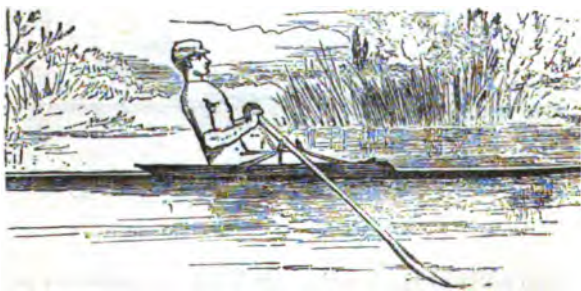


BEGINNING OF THE PULL.

them fairly by the handles. At the *beginning of the pull* bend the body till your head is well over your knees, and extend your arms as far as you can, that the blades of the sculls may be thrown correspondingly backward. With the sculls well dipped, pull toward you by at once bending the body and arms.

When in the *middle of the pull*, if the sculls are not short enough, or even if the head and body are slightly turned, one of the ends will go rather higher than the other—the right usually above. To obviate this inconvenience, before pulling a stroke, move your seat an inch or two to the right or left, without removing your feet from the centre of the stretcher. This will give you a slightly oblique position, and allow the hands to work clear of each other.

The *end of the pull* must not take place till the elbows have just come to the top of the hips; when the hands will be brought toward the chest, and the body well thrown back. But if you bring your hands too near your chest you will lose power. As the water is freed from the sculls the elbows sink, the wrists are bent up, and the backs of the hands are turned toward the fore-arms. If you properly perform this simple but apparently complex movement, you will properly *feather your sculls*; that is, turn them in such a way as to gain the greatest power when pulling, and offer the least resistance to the water when releasing them for the return stroke.



END OF THE PULL.

In the *return of the sculls* the hands must remain turned up until the sculls are turned out of the water. In the middle of the return, if the sculls are not short, or if the head

and body be turned, one of the hands goes higher than the other. As to the *degree of the immersion of the sculls*, in the middle of the pull the blades must be covered by the water. The beginner generally dips them too deeply; but that ought to be avoided, especially in calm weather. In the whole of the return, the tops of the sculls should, in calm weather, be two or three inches above the water; and in rough weather they should be higher, in order to clear it. The head should be well balanced and pliant, so that you may turn it easily with the direction of the boat.

Young boatmen should begin with a boat large enough to hold two, so that when one is tired the other may take the sculls. Do not be afraid of a little stiffness in the arms and legs; you will soon get over that.

Now about *feathering the oars*. This operation is performed at the finish of the stroke, by turning the oar as it leaves the water. While in action, the whole width of the blade is opposed to the water, one edge to the sky and the other to the bottom; but as you raise the oar from the water you reverse the position of the oar, so that the hollow part of the blade is uppermost. In making the next stroke, however, you again turn the scull so that it dips edgewise in the water. This is not so easy to describe as to do; but when you have once done it, you can do it always. Feathering is the very acme and perfection of good and graceful sculling. Be careful, however, not to raise the scull too high out of the water, or you will not be able to make a good stroke next time. A little practice—say a couple of hours daily—will soon accustom you to the proper position and action of this stroke.

#### BACKING WATER—SHIPPING SCULLS.

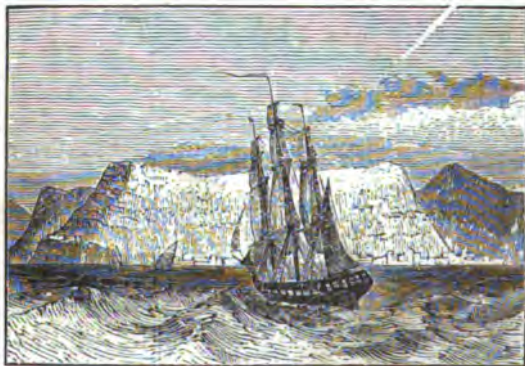
“Backing water” is performed by making with the scull or oar a movement exactly the opposite of that just described. It is necessary to perform this movement when it is desired to turn the boat, or prevent its head veering too much to



either side. The rower places the oar or scull in the row-lock against the stopper instead of against the thowl-pin, and throws the blade before him prior to dipping it into the water, bringing the handle close to the chest. When the oar is dipped, he pushes his hands forward again, until the oar is stopped by the thowl-pin, when the movement called "backing" is performed. To "hold water," when it is desired that the boat shall remain stationary, the oar is dipped in the same manner as when it is intended to "back," but no motion is made with the hands.

"Shipping the sculls" is performed when the rowers have come to the end of their journey, or when another boat is passing so closely that the sculls of the two boats may clash. It is done by lifting the scull or oar out of the row-lock in the manner we have described when speaking of "crab-catching," and suffering it to lay by the side of the boat. By throwing the handle back, it may then be readily brought into the boat, or, as it is termed, "shipped."

Remember that, however clear these directions may seem, they will be far more readily understood, and the learner will himself be enabled to carry them out more completely, if he will watch the motions of an experienced waterman or amateur oarsman, before taking a scull in hand.









## CHECKERS OR DRAUGHTS.

### INTRODUCTORY.

Checkers is a good game, though certainly inferior in variety and complication of moves to Chess. It was first played in Europe, we are told, about the middle of the seventeenth century, since which time it has received many illustrations at the hands of various writers, and afforded rational amusement to hundreds of persons of all ages and both sexes. Unlike Chess, it has not been much altered or improved during the course of years; and what it was when its rules were first printed by Mallet, the mathematician, in 1668, it remains to this day—better liked and universally understood, but still the same. It is played by the people of various countries, and in various languages is known as the Game of Ladies.

### THE GAME.

Checkers or Draughts is played on an ordinary chess-board, with twenty-four men, twelve on each side. The men move and take on the diagonals, moving one square at a time, and taking by jumping or passing over the adverse man to a vacant square beyond; and not, as in Chess, taking the place of the captured piece.

The men usually occupy the white squares, with the board so placed as to have the double corner at the right hand of the player. The pieces move *forward* in the direction on the *diagonals*, and the game is continued by each player moving alternately one square at a time. When a piece reaches the last row of squares on his opponent's side of the board, he becomes a king, and is crowned by having another piece of the same color placed on his head. The king can move *backward* and *forward* diagonally on the white squares, and both kings and pieces can take any number of their opponents that may lie in their way unprotected; that is to say, if after taking one man there should be any other piece in the same diagonal, or in any adjoining diagonals, with an empty square beyond, the player continues his march, and captures as many as he can. The game is won by capturing your adversary's men, or by blockading him in such a way as to prevent him from moving. When each player is left with a single king, or two kings, the game is usually drawn; but situations arise occasionally in which an inferior number of pieces can command superior force.

### RULES OF THE GAME.

I. The board is to be so placed as to have the white double corner at the right hand of the player.

[All the printed games are given on this plan of placing the board. It is *usual* to play on the white squares, but not *imperative*.]

II. The first move is to be taken by chance or agreement, and in all subsequent games the move is taken alternately by each player, whether the last game be won or drawn.

[Black generally moves first.]

III. Any action which prevents your adversary from having a full view of the board is not allowed, and if persisted in, loses the game to the offending player.

IV. The man touched must be moved, but the men may

be properly adjusted during any part of the game. After they are so placed, if either player, when it is his turn to play, touch a man, he must move it. If a man be so moved as to be visible on the angle separating the squares, the player so touching the man must move it to the square indicated.

[By this it is meant that a player may not move first to one square and then to another. Once moved on to the square, the man must remain there.]

V. It is optional with the player either to allow his opponent to stand the huff, or to compel him to take the offered piece.

["Standing the huff" is when a player refuses to take an offered piece, but either intentionally or accidentally makes another move. His adversary then removes the man that should have taken the piece, and makes his own move—huffs and moves as it is called.]

VI. Ten minutes is the longest time allowed to consider a move, which if not made within that time, forfeits the game.

VII. It is compulsory upon the player to take all the pieces he can legally take by the same series of moves. On making a king, however, the latter remains on his square till a move has been made on the other side.

VIII. All disputes are to be decided by the majority of the bystanders present.

IX. No player may leave the room without the consent of his adversary, or he forfeits the game.

X. A false move must be remedied as soon as it is discovered, or the maker of such move loses the game.

XI. When only a small number of men remain toward the end of the game, the possessor of the lesser number may call on his opponent to win in at least fifty moves, or declare the game drawn. With two kings to one, the game must be won in at most twenty moves.

XII. The player who refuses to abide by the rules loses the game.

The few remarks which we are about to make, as to one circumstance in draughts, could not, we conceive, be so aptly introduced anywhere else as here; we allude to the importance of having the move upon an antagonist. The value of this will, no doubt, have frequently occurred to the reader; but there are situations when it is not only useless, but detrimental. To have the move when your men are in a proper position, upon an open board, will often, in a short time, give you the power of forcing your adversary into such a situation as will render his defeat certain; but, having the move, when your men are huddled in confusion together, and you are unprepared to point an attack from any quarter, that is to say, when you are strong in number but powerless in position, will not unfrequently cause you to lose the game.

In order to know whether any one of your men have the move over one of your adversary's, you must carefully notice their respective positions, and, if your opponent have a black square on your right angle under his man, you have the move upon him. This is a general rule, and will apply to any number of pieces. A modern writer on this subject gives another method of ascertaining whether a party, whose turn it is to play, has the move; namely, by counting the squares and the men; and if the squares be odd and the men even, or the men odd and the squares even, then the party whose turn it is to play has possession of the move, and may certainly win the game, if he act judiciously.









## *YACHTING AND SAILING.*

### THE BOAT.

Pleasure-boats are generally known as cutters, yachts, yawls, luggers, or schooners. They are made of various sizes, and are rigged in various ways. But, that you should make no mistake in the *names* of the vessels you see, I will briefly describe their several characteristics.

A *ship*, properly so called, has three masts—the foremast, nearest the stem; the mainmast, in the center; and the mizzenmast toward the stern. Each of these masts is furnished with yardarms, to carry square sails; and each mast is divided into three parts—the mast, the topmast, and the top-gallantmast; which parts, again, take the names of the

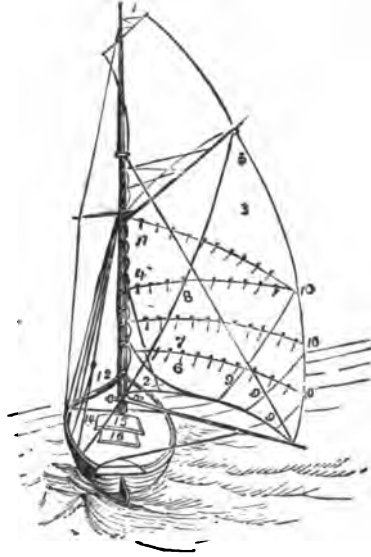
particular mast to which they belong—as the foremast, the fore-topmast, and the fore-top-gallantmast, the mainmast, the main-topmast, etc. The yardarms, which stretch across the masts, are also named after the masts on which they are placed. The body of the ship is called the *hull*, the after-part of which is the *stern*, and the fore-part the *bows*. The *bowsprit* projects from the bows, and the *rudder* hangs on the stern. Every ship has one *deck* or more, according to its size ; a *keel*, which runs underneath the structure from stem to stern ; an *anchor*, with chains attached ; a windlass, round which the *cable* is wound ; ladders, rigging, etc. The bowsprit is divided into several parts. The spar attached to it is the *jibboom* ; the two pieces hanging downward are the *martingale*, which serves as a stay to the jibboom ; and the little yard across it is called the *spritsail-yard*. The sails between the bowsprit and the foremast are called *jibs* ; and the ropes by which the seamen go aloft are known as the *standing rigging*. They are named after the mast to which they are attached, as the *fore-rigging*, the *main-rigging*, and the *mizzen-rigging*. The long flags which fly from the mastheads are called pennants, and the wide flags *ensigns*.

A *bark* is a three-masted vessel, with the mizzenmast rigged schooner fashion, with fore and aft topsails. A *schooner* is a two-masted vessel, with fore and aft sails. Sometimes she is rigged with a square sail and top-gallant-sail. A *brig* is a two-masted vessel, rigged with square sails. A *brigantine* is a sort of cross between a brig and a schooner. After which comes a large variety of smaller craft, known as the Dutch galliot, the billyboy, the smack, etc.

Most yachts partake more or less of the character of the sloop or fishing-boat. A thoroughly good yacht should be handsome in form, sufficiently broad to carry her canvas easily, and a good sailer.

Next we have a view of a pleasure-boat, running before a light breeze, with all her sails set.

When at anchor it is usual for a yacht of this kind to



PLEASURE-BOAT IN FULL SAIL (END VIEW).

1. The gaff-top-sail. 2. The foresail. 3. The mainsail. 4. Tack tricing-line. 5. Peak-line, or signal halyards. 6, 7, 8. First, second, and third reefs. 9, 9, 9. Reef earings. 10, 10, 10. Cringles. 11. Balance reef. 12. Anchor stock. 13. Windlass. 14. Fore-sheet horse. 15. Main hatch. 16. Companion and binnacle.

have two anchors, one in the water, and the other hanging at the bow.

Now that you know of what parts the yacht consists, the next thing to learn is how to manage your vessel. This is of course a matter that can really be acquired only by practice; but a few hints will suffice as a beginning.

Briefly, then, sailing is by no means so difficult an art as some imagine. Remember, however, that the *mainsheet* is

not a sail, but the rope by which the *mainsail* is controlled, after it is hoisted up and set. The mainsheet is that rope which is made fast at the outer end of the sail or of the boom. By it the sail may be hauled in-board, and set flat; by easing of the mainsheet the sail is freed from control, and allowed to swell out to the breeze.

The foresheet is the rope which is employed to control the foresail, after it is run and fairly set. The foresheet is fastened to the aft-clew of the sail, and just as it is hauled taut (tight), or eased off (loosened), so the sail itself is managed.

Every one who ventures on the water in an open sailing boat, says a competent writer, should be given strictly to understand that the most important rope, and that on which the safety of the boat and its crew depends, is the mainsheet. Next in importance is the foresheet; and if the vessel carries two head-sails, the jibsheets.

Every rope belonging to the working of the sails should be laid in a separate coil, so as to be ready at the instant of emergency. But it is especially important that the mainsheet should never be made fast, except in the most slight and simple manner. Care must be taken that it never becomes entangled, or in any way hidden from view, covered, or obstructed, whether the vessel is going before the wind, reaching, or tacking. In nine cases out of ten, the reason why boats are capsized is, that the man in charge of the mainsheet fails—from fright, confusion or inattention—to slacken or tighten it at the right moment, or that the coil becomes entangled or twisted round something on deck.

The steersman has charge of the rudder, and to him and the mainmast the proper sailing of the boat is confided. In ordinary yachting—such, I mean, as that in which you will take your first lessons—the boat keeps in sight of land, so that the steersman guides it by reference to the points on the land, and various objects at sea. To steer by means of the mariner's compass is an art which needs fuller explanation than we can here afford to give, and actual teaching at

the hands of a practical seaman. It involves, indeed, a knowledge more or less of the art of navigation ; which knowledge includes, among others, the acquisition of the science of mathematics, with logarithms, etc. Just now, however, we need not enlarge upon that branch of the yachtsman's duties.

The steersman should be careful to keep the head of the boat to the point toward which he intends to go, and move the tiller to the right or the left, according to the state of the wind, always avoiding the error of putting the helm about too quickly, or bringing the boat too sharply round. The shifting of the boat's course should be made by a gradual, firm and steady management of the tiller ; and by this means you will not lose ground, or cause the progress of the vessel to be impeded.

#### VARIOUS STYLES OF YACHTS.

I now proceed to show you the rig of the several varieties of pleasure-boats in ordinary use on our coasts.

*The Cutter Yacht* is a single-masted yacht with four sails—mainsail, main-topsail, foresail, and jib. Small boats have sometimes large jibs and no foresail. The model yacht of our time has been copied from the celebrated *America*, which, a few years since, was sent to contend in the regatta against the best English yachts.

*The Dandy-rigged Cutter, with jigger*, is a favorite with most yachtsmen. It has no boom to the mainsail, which can therefore be brailled up to a rope passing round it. The jigger is on a small mast at the stern, over which the sail projects. This is a safe style of rig, and a quick sailer. The sail is more quickly taken in by brailing it up than by lowering it down.

*The Spritsail and the Lug-sail*.—These are boats with each a single sail. They are fast and handy to use. The *Lug-sail* has a portion of the sail before the mast, which causes it to come round quickly in tacking. The *Spritsail* has the canvas abaft, and is therefore less easy to pull round.



LUGSAIL.

Of the two, the lugsail is to be preferred, as you have more power over the boat than with the spritsail ; though the canvas in the latter is flat to the wind.

*The Schooner* has two masts, with fore and aft sails, and sometimes a third sail, a jigger, raised on a spar at the stern.

*Cutter-rig, with Boom Mainsail.*—A yacht with this form of rig is generally understood to be a good sailer. It stands close to the wind, but it requires care in its management, or the weight of the boom will be likely to cause a capsize. The safer and more pretty rig is the Dandy-rig, or Ketch, in which you have the advantage of the heavy boom without its risk.

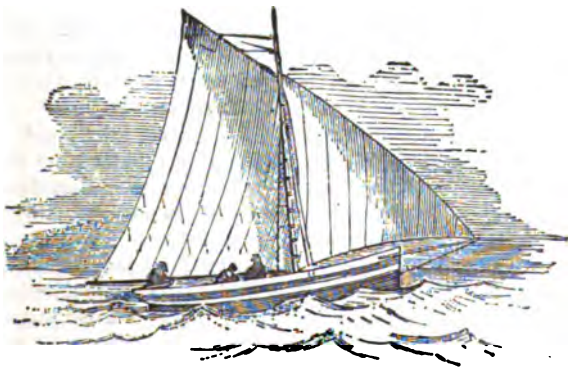
*Mainsail and Foresail.*—This rig is particularly handy when the boat is tolerably large and broad on her beam. The advantages of the triangular mainsail and foresail rig are acknowledged by all yachtsmen. The foresail should be carried a foot beyond the stem, by means of a short iron bowsprit, made to ship and unship at pleasure. The mainsail has a spar reaching from the lower part of the mast to the upper corner of the canvas. A rope is fastened to the

center of this spar, and passes through a block on the mast, by which means the sail is hoisted. This is a safe rig, as the boat goes well to windward and is easily brought about. Should a squall catch you, all you have to do is to let fly the



foresheet and put your helm a-lee, when your boat will right itself directly.

*The Balloon Foresail.*—This style of rig is much used by



BALLOON FORESAIL.

smugglers and boatmen; but for yachting purposes it is a rig to be avoided. The great foresail has a tendency to



press the boat down in the water, and consequently you are nearly always wet. But the rig has great driving power; though for a pleasure-boat it is decidedly inferior to those already mentioned.

We now come to the practical instruction for the management of the yacht.

### PRACTICAL ADVICE.

The first thing you have to do, when on board your pleasure-boat, is to *get under weigh*, that is, to sail from the harbor or starting-place. How are you to manage this? The ordinary directions given by yachtsmen and seamen would be something like this: "Ship the tiller; set the mainsail; hoist the throat nearly close up, and half hoist the peak. Bend and haul the jib out of the bowsprit end; bowse the bobstay and bowsprit well taut. Hoist the jib, and bowse it well up. Get the topmast stay, backstays, and rigging well taut. Hoist the foresail ready to cast her when her moorings are let go. Send a hand to the helm; overhaul the mainsheet and the lee runner and tackle; lower the throat, and hoist the peak of the mainsail taut up. Hoist the gaff-topsail, keeping the tack to windward of the peak halyards; and haul the slack of the sheet out before you hoist the sail taut up. Set the tack, and heave the sheet well taut."

Now, do you think you could follow these directions? I fancy you would be somewhat nonplussed to translate the various nautical terms into colloquial English. Therefore, your best plan will be to make yourselves acquainted with the principal phrases in use on board a yacht. You will not find it necessary to master all the puzzling phraseology in which the Dick Fids and Tom Taffrills of naval novelists indulge; but there is quite enough to puzzle a landsman, unless he familiarizes himself with a few necessary peculiarities of the language of the sea.

When we say a vessel is *close-hauled*, or *on the wind*, or plying to *windward*, we mean that she is steering close to the wind. Cutters are said to have good way when they are

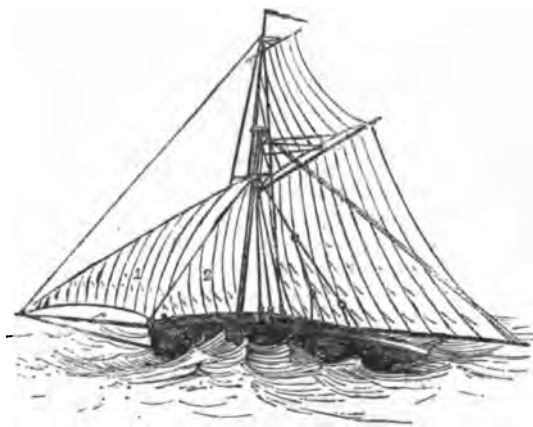
within five points of the wind; square-rigged vessels must be within six points. A vessel is said to be *sailing before the wind* when the wind is fairly at your back (aft). Her head is then sixteen points from the wind.

### THE YACHT AT SEA.

Every trade and profession has its *slang*. I do not employ the word in its mere dictionary form, as meaning "phrases used by the low, the vulgar, and the ignorant;" but as expressing the fact that the law, the army, the counting-house, the manufactory, and the shop, have each and all their well-understood and accepted technicalities. To be a barrister or a solicitor, a soldier or a merchant, a manufacturer or a trader, it will be necessary to familiarize yourself with the language peculiar to each calling. So also with boating and sailing. To become a yachtsman you must not be ignorant of the slang of the sea.

**SETTING SAIL.**—As already explained, your first task is to hook on the bobstay, and bowse down the end of the bowsprit. Then you must cast off the lashings which held the mainsail furled; look to the foresail and jib, that they are ready to be hoisted, and see that the mainsheet is clear of obstructions. Before you set the headsails you must set the mainsails, and haul out the jib on the bowsprit; but do not hoist it until the mainsail is set, and her moorings slipped. The boat should never be loosed from her moorings till the mainsail is fairly set, and the anchor weighed—that is, raised from the water, and made fast to the side of the boat. Run up the foresail directly the vessel is free. The boat's head will be canted or brought round by hauling the foresheet a-weather. When fairly under way, run up the jib, being careful that the jibsheet (or ropes) are clearly and properly trimmed. Then having got your main fairly up, haul up the peak. If there are many craft near you, so as to leave but little room for turning, you must drop or lower the peak, and set the headsails. Then, by hauling the foresheet a-weather, you can turn the boat in a very little more space than its own length.

**REEFING SAILS.**—Caution and expedition are necessary in this operation. The boat must be luffed close to the wind, or laid to; but not sufficient to allow her to come about. Ease off the jibsheet, and haul the foresail a-weather. Then haul in the mainsheet as taut as you can, and the boat will be laid to. Then you drop the peak and main sufficient for



**YACHT WITH A BREEZE ON THE LARBOARD TACK—ALL  
SAILS SET.**

the reef you require. Cast off the main tack, and take down a reef, securing it by the reef-earings to the boom. Then tie up by reef-knots all the points along the lower part of the sail. You can then set up the peak and main; ease off the sheets, and haul down the main tack. The boat is then under a reefed mainsail. If you require to take in a second or third reef, proceed in the same way; but be careful never to tie a second or third reef till the first is thoroughly secured. Look well to your reef tackle, and see all sound and taut. It is seldom necessary to reef sails in smooth seas and light breezes, but it is imperative when the wind is strong and the sea heavy.

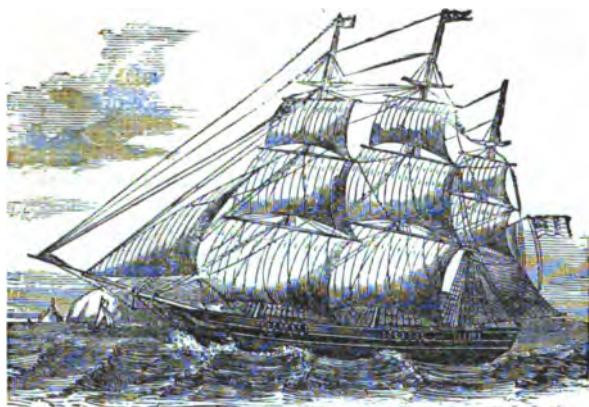
We now come to consider another and very pleasant part of the yachtsman's duties; namely:

**SAILING TO WINDWARD.**—The boat that sails fastest and nearest to windward is invariably the winner of matches, but is not necessarily the best sea-boat. Much of the success achieved by a yacht, however, is due to the manner in which it is managed; to a careful attention to the trim of the sheets and the adjustment of her sails. In sailing to windward—that is, in beating against the wind—the sails should be set as flat as possible, so that they may be eased off for running free, and sailing on a bowline. The art of sailing a boat against the wind by various zigzag tacks is a performance that needs the nicest skill, a keen, watchful eye, and frequent practice—that is, if you would do your work in a seamanlike manner.

But the art is by no means difficult to acquire. The helmsman must be careful to keep an eye on the luff of the mainsail, and should steer as close to the wind as he can. In simpler language, he must endeavor so to steer the craft as—while keeping as close to the wind as possible—to keep the sails full without allowing them to flap to and fro. In smooth water you can keep closer to the wind than in rough seas. "Keep her full" is a maxim with all yachtsmen; that is, keep the sails well blown out with the wind.

In sailing up a narrow channel to windward, the best plan is to furl the jib, and depend only on the main and foresail. Large jibs are dangerous at such times, as their driving power is apt to be too much for the steersman. When the vessel goes free, help her all you can, by easing the tacks whenever practicable.

**SAILING TO LEEWARD, OR SCUDDING,** is the art of sailing the boat when she is running before the wind. Skill and caution are more requisite than when you sail against the wind, because the sails are apt to unexpectedly gybe, when a mast or a sail may be carried away before you know where you are. Much, very much, depends on the watchfulness and skill of the helmsman. If he sees the slightest indica-



tion of the sail gybing, he must instantly put down the helm; and if in a heavy sea, the mainsail must be close-reefed or even furled. In scudding, the foresail is of little or no assistance, but the jib sometimes helps the boat forward. The jibsheets, in such a case, should be judiciously trimmed and eased off. It will generally be best, in squally weather, to drop the peak, trice up the maintack, and reef the mainsail. All this, however, depends on the force of the wind that drives you forward.

**FURLING SAILS.**—The way in which you furl the sails of a cutter or sloop yacht is this: Lift the flap of the sail over the boom; then place the aft end of the sail over the flap, hauling it taut while another man neatly rolls the loose sail, and lashes it over the gaff. The sail should never be rolled *round* the gaff or the boom. In hot weather, and likewise when wet, the sails should be furled loosely, so that the wind may penetrate and dry them. Mildew soon attacks a wet sail rolled tightly. The foresail, which is usually fastened to the forestay, should be lowered to the stem of the vessel, and rolled up. Jibs and gaff-topsails are lowered by their ropes, and stowed away below. Spritsails and





foresails are stowed and furled without being lowered. After taking out the sprit, they can be rolled up and fastened to the mast, not round it. When sails are new, they should be frequently wetted with salt water, and allowed to dry gradually. This plan will prevent mildew; rain rots sails more than sea-water.

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### *THE VELOCIPEDE.*

The newest rage is the Velocipede; it is, however, but an old rage newly revived; though the Velocipede promises to



THE BICYCLE.



become as useful as it is popular. The French, of course, claim this invention—as they claim every novelty now-a-days; but I believe the modern adaptor of the Hobby-horse to have been an Englishman residing at Paris.

The Velocipedes now in use are of two kinds—the Bicycle, with two wheels; the Tricycle, with three wheels. They are mainly constructed of wrought iron, and are worked by pedals or reels attached to the axle of the front or large wheel. The movement of the feet on either side of the driving wheel is simply an up-and-down motion similar to that of walking; and by the impulsion thus given a quicker or slower pace is accomplished at the will of the rider. The seat, or saddle, is fixed on a bar of iron a few inches above the fore wheel. The hands rest on a horizontal handle in front. This handle works on a pivot, and serves as a balancing pole, the equilibrium of the rider being preserved by a slight inclination of his body to the right or left. Indeed, the whole secret of riding a Bicycle depends on the attention given to the balance of the machine, and it is only by great practice that excellence on this machine can be attained. The two-wheeled Velocipede runs on the same principle as the Hoop; while it is kept upright, it travels forward safely. Both the Bicycle and the Tricycle are furnished with a brake, the application of which stops the motion of the wheels; and, if he is not very careful, topples the rider to the ground.

The following are the rules furnished by a master of the art for the guidance of tyros on the Bicycle:—

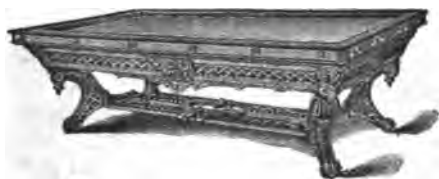
“Run beside your iron horse, leading it, as it were, with your hand, so as to familiarize yourself with its movements: this will be an affair of a few minutes merely. Then commence practicing with it on a slope, and after mounting it, let it move forward of its own accord, while you occupy yourself with studying the effects produced by the inclination which you give to the balancing pole or handle of the machine. When you thoroughly understand the action of this, place one foot on the pedal, and follow its

movements, without assisting them. The difficulty with beginners is to restrain the unnecessary expenditure of muscular force; they ordinarily perform ten times the labor that is requisite. Next repeat the experiment on level ground, having both feet on the pedals, and working them alternately with scrupulous regularity. Speed is obtained by simply accelerating this movement.

"After an hour or two's practice the tyro will be able to accomplish a distance of from thirty to forty yards without running the risk of an upset. Should the machine incline on one side, all that is necessary to be done is to remove the foot on the same side from the pedal, and place it on the ground. This can of course only be accomplished when the Velocipede is of a moderate height, the proper kind of machine with which beginners should make their first essays.

"To alight, both feet are raised from the pedals at the same instant, which has the effect of slackening the speed of the machine; the feet are then placed simultaneously on the ground without the handle being let go."

The Tricycle is at once easier to manage and safer to ride. It requires much less practice, but its speed is less rapid. It is driven in the same way as the Bicycle, by alternate pressure with both feet.





### ANGLING.

The art of fishing varies by circumstances. To be successful, it must be based on a knowledge of the habits of fish—different fishes having different tastes, and even the same kind of fishes differing in habits, according to different localities. We will try to give general information on the subject, through which a smart boy, by using his eyes and judgment, may soon become a good angler.

The articles required by the angler are as follows :

#### THE ROD OR POLE.

For small fish—chub, dace, roach, minnows, sunfish, and small white perch,—a black alder or willow rod, about eight feet in length, will answer; but for catching larger fish, a carefully made rod is necessary. Besides, it is much pleasanter to have a good rod. It can be had at the shops where they sell fishing-tackle, in great variety of shape and price. One with four joints or pieces—the butt and two succeeding pieces of ash, and the last joint or tip of lance-wood—will be the best for most purposes. It should have two tips, one short and one long. The wood should be

straight-grained, and each joint should have eyes, through which the line will run easily. A rod of cane, without joints, is very good when it can be kept near the fishing-ground, as it is not very portable. Whatever the material, the rod must be straight, tapering from butt to point, tight in the joints, and with a good spring to it.

### THE REEL.

Without a reel you would lose many a large fish, by having your line broken. The reel is generally made of brass, but sometimes of German silver, and may be either plain or multiplying. The latter is best, but, being complex, is liable to get out of order. The plain imported reel is very good; but if you are able to obtain a multiplying reel, get an American one, as those made in England are very apt to be fitted with brass internal wheels, the cogs of which are very poor. A reel that will hold about fifty yards of line is enough for a boy's purpose.

### THE LINE.

Different lines are required for different fish. For catching shiners, a stout piece of homespun thread will answer, and with this, and a No. 11 hook, you can capture a half-pound sunfish or perch, if need be. For your principal line, a plaited silk, or well twisted hemp, is best, measuring fifty yards. It should be boiled in linseed oil before being used, which will add to its durability, and render it less liable to kink. For large pike, where you troll for them, you should get a stout cotton or hemp line.

### FLOATS.

Floats are usually made of corks or quills—sometimes of red cedar or white pine, and are either egg-shaped, or made like two long, narrow cones, joined at their bases. For small fish, the quill-float is preferable.

### THE HOOK.

Your hook has to be proportioned to the kind of fish you catch, and will vary from the little fly hook, No. 12, up to the salmon, No. 0, which is large enough for any fishing a boy will ever get. As to the style, the Limerick (A B) is decidedly our favorite; although, for some fishing, the Kirby (C) is excellent.

The sizes of both kinds of hooks are the same.

There is also a pattern called the Virginia hook, which is very popular with Southern fishermen. It is shaped like the Kirby, with a Limerick barb, and is longer in the shank than either.

After getting the kind of hook to suit your fancy, test it, and see that it has a good temper, and that the point is sharp and perfect.

### SWIVELS.

These are very necessary. They are generally made of blued steel or brass, and should be placed at various parts of the line, one being within a foot or eighteen inches of the bait.

### LEADERS.

The leaders, to which the hooks are attached, are made either of twisted horse-hair, sea-grass, or silk-worm gut—the latter being the most elegant, almost imperceptible in water, and necessary in taking shy fish.

### SINKERS, OR DIPSIES.

These are of all sizes, from a small shot, half split and then closed on the line, to a heavy lead, of a pound or more, used in sea-fishing. A swivel sinker is best, as it prevents the line from being entangled, and if you troll aids in spinning the bait.

### NETS.

The two nets are the landing and bait. Their uses are expressed in their names. The landing-net is a purse-like net,

with half an inch mesh, and is made about sixteen inches in diameter and two feet in length, set on a stout brass wire ring, and attached to a light but strong hickory handle, six feet long. This is used to land your fish when you have fairly captured him.

#### THE CLEARING-RING.

This is a ring weighing from a quarter of a pound to six ounces, which is tied to stout cord, and when the line is caught in some obstacle under water, is placed around the line, and sent down to clear the way.

#### BAITS.

The ordinary bait in common fishing is the *angle-worm*, as it is called, which may be dug up in any loamy soil, especially in damp situations, or found by rolling over logs, or lifting planks that have lain for some time on the ground. There are other species of worms sometimes used, such as the *brandling*, which you will find about old dung-heaps, and the *marsh-worm*, which has a broader, flatter tail than the *angle-worm*.

The grasshopper, used without a sinker, so as to float on the surface, is a killing bait for trout, and the large sunfish, red-eyes, or yellow perch. Sunfish will bite readily, too, at the common black cricket, if it be left floating on the surface.

Shiners and dace are both used as bait, and chub for large fish. They must be put on alive.

A writer on this subject says:

"All game-fish take their prey by swallowing it head first, not liking the prickles of the dorsal fin to stick in the belly. So I insert my hook carefully in the gill-cover of my bait, which the little fellow hardly feels, and let him play about, until my friend calls for his breakfast."

For striped bass, or rock-fish, trout, and white perch, shad-roes is an excellent bait in its season.

In salt or brackish water, the soft or shedder crab, the shrimp, the soft and hard clam, are much used.

For many ground-fish, dough, or dough and cheese, mixed with cotton, is capital.

A frog, either whole or in parts, is capital for pike, pickerel, or pike-perch, in some localities.

Spoon-bait consists of the bowl of a spoon, silvered on the convex, and painted red on the concave side, with one or two hooks fastened at the top end, and set on the line. Drawn quietly through the water, the black bass and pickerel dart at it readily. This can be bought at any fishing tackle depot.

In addition to these, there is the artificial fly, the most elegant of all baits for trout and salmon; and a great many others, which a smart boy will find in the woods and about the streams, in the shape of flies and beetles. The three main baits are, however, artificial flies, earth-worms, and small fish. In getting the latter, do not get those fish with stiff, prickly back-fins, such as sticklebacks and sunfish, no large fish liking to have his throat lacerated with their sharp spines. Even that voracious fellow, the pike, will hardly venture on a young sunfish, however hungry he may be.

#### MISCELLANEOUS MATTERS.

Besides the foregoing, you should have with you always a little leather case containing, besides your extra hooks, etc., a pair of small pliers, scissors, some shoemaker's wax in a piece of soft leather, and a piece of stout cord, to be waxed and wrapped around your rod, in case it should break, and you would need to splice it. A fish-basket, and conveniences of that sort, should be provided.

#### GENERAL DIRECTIONS.

Look out for wind and weather. The south wind, and after that the west, is considered the best by all experienced anglers, from Walton down, and a cloudy, though not a

cold day, is set down as favorable. The best time of day is early in the morning, and late in the afternoon.

Be cautious. Fish are shy. Never show yourself near where the fish lie, if you can help it. Fish, like the Irishman's gun, was made to shoot round a corner. Many a big trout, or huge black bass, has been captured while he lay hidden under an overhanging bank, by the skillful angler dropping or casting his bait gently in his vicinity. Do not let your shadow fall in the water.

### THE SALMON.

This is the noblest of all fish, and to be found in but few places in this country. It is confined to the States of Maine, California, and Oregon, and some of the Western lakes. Occasionally a few make their way up the Hudson. The time of taking them is from April to July, and they are treated, either to the fly, worms, or minnows. You want a heavy rod, with a very large reel, and from three to six hundred feet of line. A swivel sinker and cedar float are to be used, when you fish with live bait, and your hook is a No. 0, 1, 2, or 3, Limerick, with a strong leader of twisted gut, from three to six feet in length.

For worm-fishing, put on your worm head first, and leave about a half inch of the tail to wriggle ; throw gently in the current, draw it up quietly after it has floated down, keeping the bait continually in motion. Keep a tight line when he bites, but do not strike too soon. Allow him to gorge, then strike suddenly and sharply. If the bite should be only a sudden jerk, pay no attention to it—it is merely a nibble, but wait till he returns. When he does, look sharp. Play him gently but firmly. Let him have line enough as he goes from you, but as he returns, reel up. Try and keep him clear of stumps and rocks ; be patient, and as cool as you can, and he will exhaust himself. Draw him gently to shore, put the hook in his gills, and land him.



## THE TROUT.

This fish is dark gray above, of a light gray, or cream color, on chin, throat and belly; the back and sides having many lighter gray, brown, or dirty white spots, which do not show themselves on the fins. The breast and belly-fins are yellowish; teeth, gums, and mouth of a purplish tinge; length two feet. It has a finer flavor than the lake trout.

For this fish you want a strong rod, and spoon-bait or revolver. Your line must be stout. You troll for him. You manage your fish as in taking salmon.

## PIKE.

The varieties of this fish are numerous. Besides the true pike, there is the pickeral, and, in the West and Southwest, the *Muskelonge*. Then there is a fish known on the Ohio and its waters as the salmon, but it is really the

## PIKE-PERCH,

Which is taken in the same manner, and is a bold and game fish.

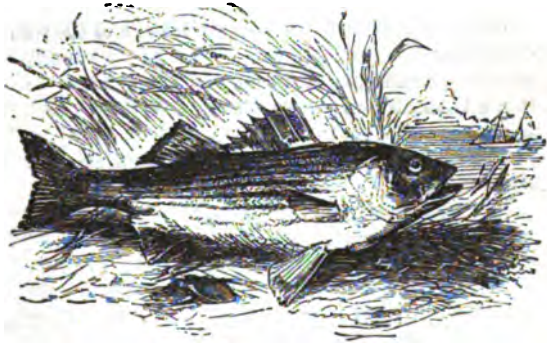
For bait you can use minnows, large chubs, small suckers, red-horse, or frogs—he is not particular. An extra swivel or two, here and there, in the first three yards of your line, may be useful.

## THE PERCH.

In this family you will find the white, yellow, and black or red perch. In the West and Southwest, they call the black bass *black perch*, but he is a different fish. Perch-fishing is very pretty sport. You do not require a very strong line, nor stout pole, and you will rarely, unless with a big fellow, have occasion to use the reel. He is a quick biter, and scarcely ever nibbles. The bait may be small minnows, shrimp, or worms—the latter almost always good in fresh water. Great numbers are taken in rivers, from a little before the flood of tide to the hour after, just outside

of the channel-grass, with a bow-line, made with a whalebone, which is kept near the bottom by a dipsy. Each end of the bow is furnished with two or three hooks, set on four or five inches of gut, and baited with worms. Sometimes five or six are caught at once. From May to July is their best season, and the hook is a Limerick trout, from 2 to 5 in size.

### STRIPED BASS, OR ROCKFISH.



This is a fine game fish, abounding in the rivers, bays, and inlets of our Atlantic coast, and in the spring of the year ascending the rivers to spawn. The rod and tackle required is the same as for the salmon. The bait is minnow, shiner, or shad-roë, and when in the bays or mouths of rivers, shedder crabs, shrimp, and shad-roë in their season. In boat fishing, in still water, you use a cedar or large cork float, but in fishing at the bottom of dams or in swift currents—capital places—you have no float, and no other sinker than a plain swivel.

You manage them, in striking and taking, like the salmon. They can be caught also by trolling, with either squid or spoon-bait, or minnow.

## SUNFISH.

There are several varieties. An extemporized rod, according to the place you fish, a light line, a No. 7, 8 or 9 hook, a lively worm or a grasshopper, and you have him. He loves, like the red-eye, to lie in holes under the bank, and in tolerably deep water. His spines protect him from the larger fish, and he is quite game and fearless, as well as very handsome.

## BLACK BASS.

This fish is peculiar to the Western lakes, and the streams running into the great rivers of the West. It resembles, in general appearance, the sea-bass, but is not black, though it has a blackish appearance above. The best bait is the minnow or chub, to be caught in their vicinity, or the brooks round about; and if you want big fish, use tolerably large bait.

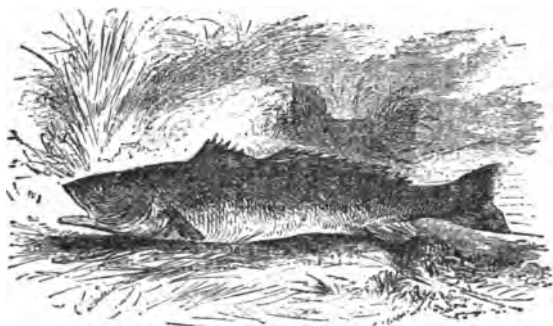
You take a medium-sized rod, with about fifty yards of line, and a yard leader. A swivel sinker, large enough to keep your bait from the surface, and a float so large that your bait cannot pull it under, are required. Put your hook through the gill-cover of the chub, set your float from three to six feet deep, according to the depth of the hole, and throw it gently in. Do not strike the first time the float goes under. Wait for the second time, and then strike. Play him well, giving him line in proportion to his size and strength. He plays game for a while, but soon gives up. A landing-net, or your finger in his gills, will secure him.

The above directions, with little variation, will answer for the pike-perch in the Western streams.

## MULLET

Bites a little better at a worm. You must always fish on the bottom for these, with a small hook, and any moderately strong line. They require no skill to secure, and the coarsest and cheapest tackle will answer.

## WEAKFISH.



This is sometimes called wheatfish, and sometimes squeeteague. He has an even tail, speckled back and sides, one or more sharp, long front teeth in the lower jaw, and yellowish ventral fins. He is found chiefly in salt or brackish waters, in New York, Connecticut, and Massachusetts. He bites at shrimp and shedder crab, and is to be caught with the same tackle and in the same manner as the striped bass, with whom he herds. They will be found, however, in rather deeper water, farther from shore, and more in the eddies.

## CARP, OR TENCH.

This is a naturalized fish in the Eastern part of this country, though there is a fine large carp in the Western waters. The mode of taking both is the same. You require strong tackle; for he is a heavy fish sometimes, and strong; a light quill float, a short leader of gut, and a light-colored worm—a brandling being better than an angle-worm. Fish on the bottom or near it. He is a very shy fish, and you had better bait the spots you mean to fish the day before, by throwing in bread-crumbs, chicken-entrails, or lumps of dough.

## EEL.

There is good sport sometimes with this fellow, in bobbing ; but he is not much liked on a hook, from his habit of twining the line, and the slime he leaves on your fingers if you handle him. He will be found everywhere, especially in muddy bottoms, and boys need no instruction about catching him. Bobbing for eels is very amusing sport. You string worms on threads, by running a blunt-pointed long needle through them from head to tail. When you have enough strings threaded, you tie the ends together, and then fold them into a regular hank, like a hank of yarn. This you double and treble, until it is about four inches long. Through the middle you tie a stout cord, to the bottom of which is a round dipey. Over this last the two ends of the bunch, which should be about the size of a boy's fist, hang. You anchor your boat on the muddy flats of a river, at high tide, or lean over the bank of a creek or river at a muddy bottom, and drop in your bob and sinker. Presently you feel a sharp pull. Your eel has his teeth entangled in the thread, and cannot generally let go until he is in the boat, or on the bank.

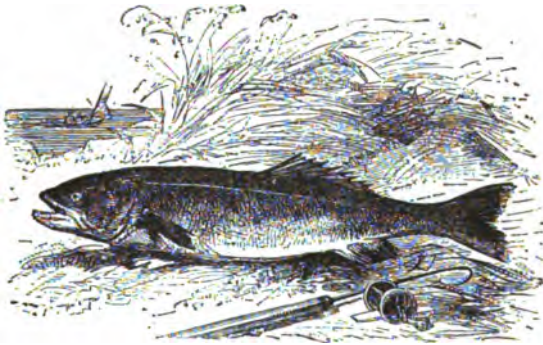
The way to grasp an eel on the hook, is to place the second finger on one side of him, and the first and third on the other, about an inch and a half from his neck. Then by pressing the fingers together he cannot move, and you may take the hook from his mouth, and throw him in your basket.

## CATFISH.

The ordinary catfish, bull-head, or bull-trout, is little prized, and may be caught by ground-bait, either a worm, piece of beef, or dough-bait. But the blue catfish of the Western waters fights very well ; and there is a variety, called the white catfish, which comes from the sea in the East, to spawn yearly, about June and July, that is game, and rather handsome. He is more slender than the others, semi-transparent when held to the light, has a forked tail like a herring, and weighs from four ounces up to four pounds.

He may be caught like the other. In the Schuylkill River, a number were kept from returning to the sea by the erection of the dam at Fairmount, and they bred in the river in great numbers.

### BLUEFISH.



This fish is taken by trolling with the artificial squid, a piece of lead, mother-of-pearl or bone, about four inches long, with the bend of the hook at right angles with the flat side of the squid. The line is cotton, stout, and from forty to sixty yards long. When the fish is hooked, haul in steadily and without intermission, or the fish will throw himself off.

### SHEEPSHEAD.

He has a smutty face, banded sides, prominent eyebrows, a grooved dorsal fin, extending entirely down his back, and a queer mouth, not unlike a sheep's, whence the name. To capture him you require a strong cord, a quarter of an inch in diameter, from twenty to fifty yards long, a heavy sinker, and a stout blackfish hook, and either soft-shell clam, with the shell on, or small rock-crab, and fish near the bottom.

There is a fresh-water sheepshead, caught at times in the lakes, but he is worthless, his flesh being tough, leathery, and disagreeable.

#### ROACH.

This is a silver-sided handsome fish, small, and considered poor eating. He may be taken in most of the rivers in the eastern part of the Northern States, in the same manner as the sunfish. He will bite well at small lumps of dough.

#### BLACKFISH.

He is sometimes called the tautog. He may be found in the bays from Cape May to Cape Cod. Striped bass tackle, and soft-shelled clam bait, are wanted for the blackfish; but he will often bite readily at the large salt beach-worm. You must look for him on rocky bottoms; and he will not bite well during a thunder-storm, nor in dull weather.

#### CODFISH.

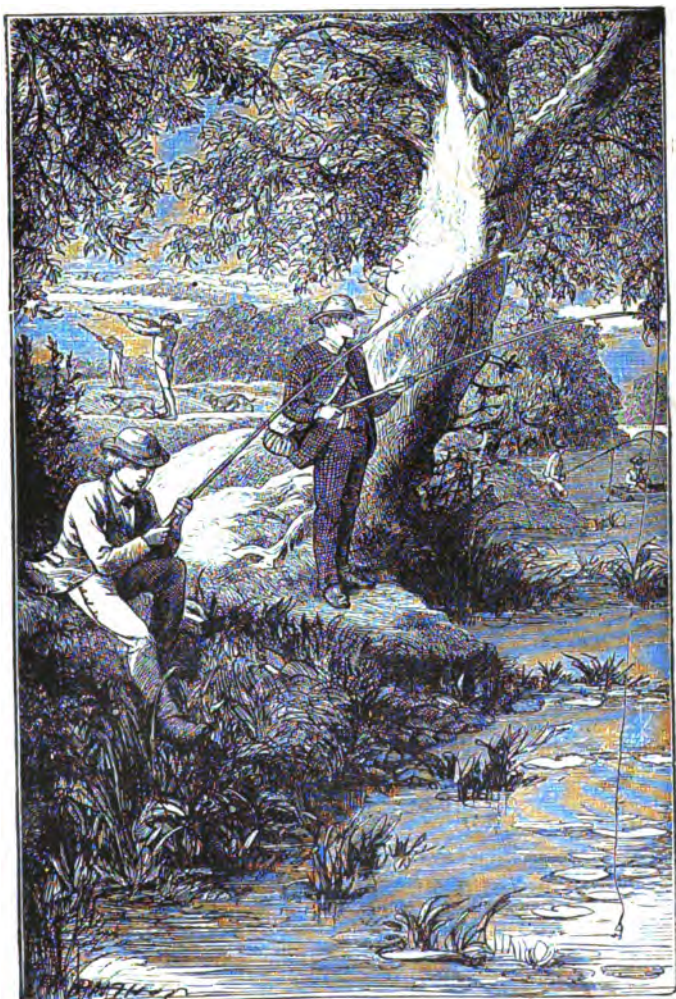
Off the coast of Massachusetts these fish are mostly taken. There is no art in catching them. A coarse, strong cord, a large blackfish hook, a piece of mud-clam, or moss-breaker, and a heavy sinker. They bite fiercely.

#### TOM COD.

This, sometimes called the frostfish, looks like a young codfish, and is caught in all the bays, inlets, and mouths of rivers along the Atlantic coast. It is a little fellow, running from six to fifteen inches in length. He can be taken with the simplest tackle, and with any bait.

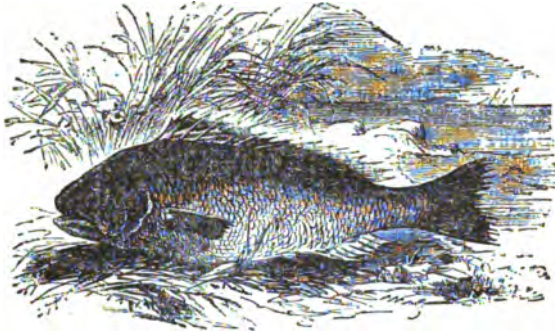
#### SEA-BASS.

This fish is well known to all who are likely to fish for him. Sometimes boys from New York, or other large cities on the coast, make an excursion in company with older persons, in the steamboats which are chartered for such a purpose during the summer months. All one has to do is to take with him about eighty feet of stout hemp line, with









two or three No. 1 Kirby hooks, and a dipsey weighing a pound. This, with hard clams, well salted, for bait, and a pair of old gloves, to keep the hands from being chafed by hauling on the line so much, completes his outfit. He will be apt to catch some porgies at the same time.

The other sea-fish boys are likely to meet with are flounders and smelt. The former are caught near New York and Boston, and all along the coast of the Middle States, with a small drop-line, No. 8 hook, and soft clam bait. The smelt is taken in the rivers of Massachusetts, New York, and New Jersey, where they run to spawn in March and April, and return again in October and November. They are caught with a small line, a No. 2 or 3 trout hook, a short leader, and pieces of minnow or frog.

There are many other fish which our space does not permit us to describe. We have been obliged to content ourselves with a few remarks about the best known specimens, and must trust to our young friends to improve their knowledge, as they may easily do, by personal observation, and by inquiry among the hardy fishermen who are to be found at all our sea-side resorts, and are always ready and willing to gratify the curiosity that springs from a praiseworthy desire to gain knowledge.

## THE CHERRY CHEAT.

Cut two longitudinal slips out of a card, as *a b c d* (Fig. 1); also cut out an oval above these slips, as *e*. Take the

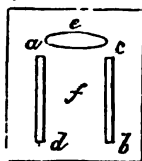


Fig. 1.

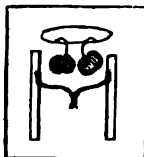


Fig. 2.

part (*f*) between the two longitudinal apertures, with your finger and thumb, and draw it toward you, until the card be bent into a half-circle; pass part

of *f* through the oval, *e*, and then, through the part of *f* so passed through *e*, introduce one of two cherries, whose stems grow together. Let the stems and also *f*, pass back through the oval; put your card as much in the original position as possible again, and it will appear as Fig. 2. The puzzle is to get the cherries off without breaking their stems, or damaging the card. It is only to be done in the manner described for putting them on.

## THE WOLF, THE GOAT, AND THE CABBAGES.

Suppose a man has a wolf, a goat, and a basket of cabbages, on the bank of a river, that he wishes to cross with them, and that his boat is only big enough to carry one of the three besides himself. He must, therefore, take them over one by one, in such a manner that the wolf shall have no opportunity of devouring the goat, or the goat of devouring the cabbages. How is he to do this?

*Answer.* First, he takes over the goat; he then returns, and takes the wolf; he leaves the wolf on the other side, and brings back the goat; he now takes over the cabbages, and comes back once more, to fetch the goat. Thus, the wolf will never be left with the goat, nor the goat with the cabbages.

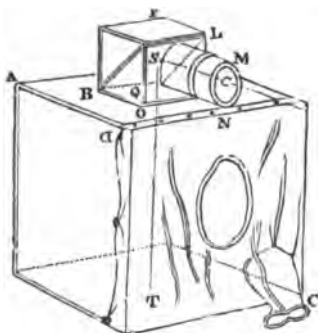
*OPTICAL AMUSEMENTS.*

The science of optics affords an infinite variety of amusements, which cannot fail to instruct the mind as well as delight the eye. By the aid of optical instruments we are enabled to lessen the distance to our visual organs between the globe we inhabit and "the wonders of the heavens above us;" to observe the exquisite finish and propriety of construction which are to be found in the most minute productions of the earth; to trace the path of the planet in its course round the magnificent orb of day, and to detect the pulsation of the blood, as it flows through the veins of an insect. These are but a small portion of the powers which this science offers to man; to enumerate them all would require a space equal to the body of our work: neither do we propose to notice, in the following pages, the various instruments and experiments which are devoted solely, or rather, chiefly, to purposes merely scientific; it being our intention merely to call the attention of our juvenile readers to such things as combine a vast deal of amusement with much instruction; to inform them as to the construction of the various popular instruments; to show the manner of using them, and to explain some of the most attractive ex-

periments which the science affords. By doing thus much, we hope to offer a sufficient inducement to push inquiry much further than the information which a work of this nature will enable us to afford.

### THE CAMERA OBSCURA.

We give our young friends a brief description of this optical invention ; though very common, it is extremely amus-



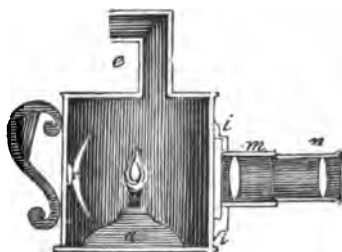
ing ; almost every one has seen it, but few persons know how to construct it. A C represents a box of about a foot and a half square, shut on every side except at D C ; O P is a smaller box, placed on the top of the greater ; M N is a double convex lens, whose axis makes an angle of forty-five degrees with B L, a

plane mirror, fixed in the box, O P ; the focal length of the lens is nearly equal to  $CS + ST$ , i. e., to the sum of the distances of the lens from the middle of the mirror, and of the middle of the mirror from the bottom of the large box. The lens being turned toward the prospect, would form a picture of it, nearly at its focus ; but the rays being intercepted by the mirror, will form the picture as far before the surface as the focus is behind it, that is, at the bottom of the larger box ; a communication being made between the boxes by the vacant space, Q O. This instrument is frequently used for the delineation of landscapes : for which purpose, the draughtsman, putting his head and hand into the box, through the open side, D C, and drawing a curtain round to prevent the admission of the light which would disturb the operation, can trace a distinct outline of the picture that appears at the bottom of the box.

## THE MAGIC LANTERN.

The object of this ingenious instrument is to represent, in a dark room, on a white wall or cloth, a succession of enlarged figures, of remarkable natural or grotesque objects. The figure on this page is a representation of one. It consists of a tin box, with a funnel on the top, represented by *e*, and a door on one side of it. This funnel, by being bent, as shown in the figure, serves the double purpose of letting out the smoke, and keeping in the light. In the middle of the bottom of the box is placed a movable tin lamp, *a*, which must have two or three good lights, at the height of the centre of the polished tin reflector, *c*. In the front of the box, opposite the reflector, is fixed a tin tube, *m*, in which there slides another tube, *n*. The sliding

tube has, at its outer extremity, a convex lens, of about two inches diameter; the tube, *m*, also has a convex lens fixed in it, as shown in the figure, of three inches diameter. The focus of the smaller of these lenses may be about five inches. Between the tube, *m*,



and the lamp, there must be a slit or opening (as at *i*), to admit of the passage of glass slides, mounted in paper or wooden frames, such as are represented on next page; upon which slides it is that the miniature figures are painted, which are intended to be shown upon the wall. The distinctness of the enlarged figures depends not only upon the goodness of the magnifying glass, but upon the clearness of the light yielded by the lamp, *a*. It may be purchased ready made of any optician, or toy store.

*To paint the Glasses.*—Draw on a paper the subject you

desire to paint. Lay it on a table or any flat surface, and place the glass over it ; then draw the outlines, with a very



fine pencil, in varnish mixed with black paint, and, when dry, fill up the other parts in their proper colors. Transparent colors must be used for this purpose, such as carmine, lake, Prussian blue, verdigris, sulphate of iron, tincture of Brazil wood, gamboge, etc. ; and these must be tempered with a strong white varnish, to prevent their peeling off. Then shade them with black, or with bistre, mixed with the same varnish.

*To exhibit the Magic Lantern.*—The lamp being lighted, and the room darkened, place the machine on the table, at some distance from the white wall or suspended sheet, and introduce into the slit,  $\epsilon \epsilon$ , one of the slides represented above, with the figures inverted. If the movable tube,  $n$ , be then pushed in or drawn out, till the proper focus be obtained, the figures on the slide will be reflected on the wall, in their distinct colors and proportions, with the appearance of life itself, and of any size, from six inches to seven feet, according to the distance of the lantern from the wall. Movements of the figures are easily made by painting the subject on two glasses, and passing both through the groove at the same time.

*To represent a Tempest.*—Provide two plates of glass, whose frames are so thin that they may both pass freely through the groove of the common magic lantern at the



same time. On one of these paint the appearance of the sea, from the slightest agitation to the most violent commotion ; representing first, a calm ; afterward a small agi-

tation, with some clouds ; and so on to the end, which should exhibit a furious storm.

These representations are not to be distinct, but run into each other, that they may form a natural gradation ; and great part of the effect depends on the perfection of the painting, and the picturesque appearance of the design.

On the other glass, paint vessels of different forms and dimensions, and in different directions, together with the appearance of clouds in the tempestuous parts.



Both glasses being done, pass the first slowly through the groove ; and when you come to that part where the storm begins, move it gently up and down, which will produce the appearance of a sea that begins to be agitated, and so increase the motion till you come to the height of the storm. At the same time introduce the other glass with the ships, and, moving that in like manner, they will exhibit a natural representation of the sea, and of ships in a calm and in a storm. As the glasses are drawn slowly back, the tempest will seem to subside, the sky grow clear, and the ships glide gently over the waves.

### THE APPARITION, OR GHOST.

Inclose a small magic lantern in a box large enough to contain a small swing dressing-glass, which will reflect the light thrown on it by the lantern in such a way that it will pass out at the aperture made at the top of the box, which aperture should be oval, and of a size adapted to



the cone of light to pass through it. There should be a



flap with hinges to cover the opening, that the inside of the box may not be seen. There must be holes in that part of the box which is over the lantern, to let the smoke out; and over this must be placed a chafing-dish, of an oblong figure, large enough to hold several lighted coals. This chafing-dish, for the better carrying on the deception, may be inclosed in a painted tin box, about a foot high, with a hole at top, and should stand on four feet, to let the smoke of the lantern escape. There must also be a glass planned to move up and down in the groove, *a b*, and so managed by a cord and pulley, *c d e f*, that it may be raised up and let down by the cord coming through the outside of the box. On this glass, the spectre (or any other figure you please) must be painted, in a contracted or squat form, as the figure will reflect a greater length than it is drawn.

When you have lighted the lamp in the lantern, and placed the mirror in a proper direction, put the box on a table, and, setting the chafing-dish in it, throw some incense in powder on the coals. You then open the trap-door and let down the glass in the groove slowly, and when you perceive the smoke diminish, draw up the glass that the figure may disappear, and shut the trap-door.

This exhibition will afford a deal of wonder; but observe, that all the lights in the room must be extinguished, and the box should be placed on a high table, that the aperture through which the light comes out may not be seen.

#### INGENIOUS ANAMORPHOSIS.

This recreation shows how to draw, on a flat surface, an irregular figure, which shall appear, when seen from a proper point of view, not only regular, but elevated. Provide a thin board, about two feet long and one foot wide, as *A B D*, and place thereon a circular piece of card or stiff drawing paper, on which a distorted figure is to be drawn, that, being viewed from the point *H*, shall appear regular, and exactly resembling that which is placed at *M F*.

Fix at the end of the board an upright piece, *I*, of thin



the glass, M F, was placed, and in the same form that it was painted on the glass. It appears to the eye even elevated above the surface of the board on which the drawing is placed, and thereby makes a remarkable and pleasing illusion.

#### SINGULAR ILLUSION.

Affix to a dark wall a round piece of paper an inch or two in diameter, and a little lower, at the distance of two feet on each side, make two marks; then place yourself directly opposite to the paper, and hold the end of your finger before your face in such a manner, that when the right eye is open, it shall conceal the mark on the left, and when the left eye is open, the mark on the right; if you then look with both eyes to the end of your finger, the paper, which is not at all concealed by it from either of your eyes, will, nevertheless, disappear.

#### ANOTHER.

Fix, at the height of the eye, on a dark ground, a small round piece of white paper, and a little lower, at the distance of two feet to the right, fix up another, of about three inches in diameter; then place yourself opposite to the first piece of paper, and, having shut the left eye, retire backward, keeping your eye still fixed on the first object; when you are at the distance of nine or ten feet, the second will entirely disappear from your sight.

#### THE CONJUROR'S JOKE.

Take a ball in each hand, and stretch your hands as far as you can, one from the other; then state that you will contrive to make both the balls come into either hand, without bringing the hands near each other. If any one dispute your power of doing this, you have no more to do, than to lay one ball down upon the table, turn yourself, and take it up with your other hand. Thus both the balls will be in one of your hands, without their approaching each other.

## THE SENTINEL EGG.

Lay a looking-glass upon an even table ; take a fresh egg, and shake it for some time, so that the yolk may be broken and mixed up with the white. You may then, with a steady hand, balance it on its point, and make it stand on the glass. This it would be impossible to do while the egg was in its natural state.

## THE BRIDGE OF KNIVES.

To erect the bridge of knives, you must first place three glasses, or small cups at the corners of a supposed triangle, and about the length of one of the knives you use distant from each other, upon a table, the floor, or any even surface. Then take three knives, and arrange them upon the glasses in the manner represented by the cut. The blade of No. 1 (as you may perceive by inspecting the engraving) goes over that of No. 2, and the blade of No. 2 passes across that of No. 3, which rests on that of No. 1. The knives being placed in this position, their blades will support each other.



## EATABLE CANDLE ENDS.

Peel some large apples that are rather of a yellow tint ; cut several pieces out of them in the shape of a candle end, round, of course, at the bottom, and square at the top ; in fact, as much as possible like a candle that has burnt down within an inch or so. Then cut some slips out of the insides of sweet almonds, fashion them as much in the shape of spermaceti wicks as you can, stick them into your mock candles, light them for an instant, so as to make their tops black, blow them out again, and they are ready for use. When you produce them, light them (the almond will readily take fire, and flame for a few moments), put them into your mouth, chew and swallow them one after another. This may well be called the juggler's dessert.



### THE PERILOUS GOBLET.

To fill a glass with water, so that no one may touch it without spilling all the water. Fill a common wine-glass or goblet with water, and place upon it a bit of paper, so as to cover the water and edge of the glass ; put the palm of your hand on the paper, and taking hold of the glass with the other, suddenly invert it on a very smooth table, and gently draw out the paper ; the water will remain suspended in the glass, and it will be impossible to move the glass, without spilling all the water.

### TO LIGHT A CANDLE BY SMOKE.

When a candle is burnt so long as to leave a tolerably large wick, blow it out ; a dense smoke, which is composed of hydrogen and carbon, will immediately arise. Then, if another candle, or lighted taper, be applied to the utmost verge of this smoke, a very strange phenomenon will take place: the flame of the lighted candle will be conveyed to that just blown out, as if it were borne on a cloud, or, rather, it will seem like a mimic flash of lightning proceeding at a slow rate.

### WINE UPON WATER.

Half fill a glass with water, throw a bit of the crumb of a loaf into it, about the size of a nut, pour some wine lightly on the bread, and you will see the water at the bottom of the glass, and the wine floating at the top of it.

## THE THUMB STRING.

This is a very simple trick, but by performing it quickly, you may surprise and puzzle a spectator very considerably. Wind a piece of string round your thumb, thus :—Let one end of it (*a*) drop between the thumb and forefinger of your left hand ; then wind the other part, which you retain in your right hand, two or three times round your thumb ; next, make a little loop (*b*) with the same end, which hold between your finger and thumb. Now let go the end (*c*) and take hold of the end (*a*), which you must have left about six or eight inches long, and you may make a spectator fancy you pass it through the loop, and take hold of it again, when so passed through, in the twinkling of an eye. To increase the surprise, you may make the loop as small as possible. This apparent piece of manual dexterity is performed by passing that end of the string marked *a*, as quickly as possible round the top of the thumb, so as to come between the forefinger and thumb : it will thus get into the loop, and you will seem to have passed the end through it.



## TO SUSPEND A RING BY A BURNT THREAD.

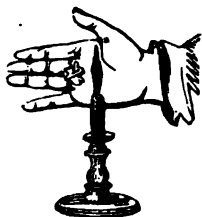
The thread having been previously soaked two or three times in common salt and water, tie it to a ring, not larger than a wedding ring. When you apply the flame of a candle to it, though the thread burn to ashes, it will yet sustain the ring.

## THE FASCINATED BIRD.

Take any bird, and lay it on a table ; then wave a small feather over its eyes, and it will appear as dead, but taking the feather away, it will revive again. Let it lay hold of the stem part of the feather, and it will twist and turn like a parrot ; you may likewise roll it about on the table just as you please.

### THE WONDERFUL RE-ILLUMINATION.

After having exhibited the trick of lighting a candle by smoke, privately put a bit of paper between your fingers,



and retire to one corner of the room with a single candle, and pass the hand, in which you hold the paper, several times slowly over the candle until the paper takes fire ; then immediately blow the candle out, and presently, pass your hand over the snuff, and relight it with the paper.

You may then crumple the paper, at the same time extinguishing the flame, by squeezing it suddenly, without burning yourself. If this trick be performed dexterously, it is a very good one. It is not necessary for the performance of this trick that all the other lights in the room should be extinguished ; in fact, the trick is more liable to a discovery in a dark room, than in one where the lights are burning, on account of the light thrown out by the paper while it is burning, previous to the re-illumination.

### THE MOVING PYRAMID.

Roll up a piece of paper, or other light substance, and privately put into it any small insect, such as a lady-bird, or beetle ; then, as the creature will naturally endeavor to free itself from captivity, it will move its covering toward the edge of the table, and when it comes there, will immediately return, for fear of falling ; and thus, by moving backward and forward, will excite much diversion to those who are ignorant of the cause.

### THE MYSTERIOUS BOTTLE.

Pierce a few holes, with a glazier's diamond, in a common black bottle, place it in a vase or jug of water, so that the neck only is above the surface. Then, with a funnel, fill the

bottle, and cork it well, while it is in the jug or vase. Take it out, and notwithstanding the holes in the bottom, it will not leak ; wipe it dry, and give it to some person to uncork. The moment the cork is drawn, to the party's astonishment, the water will begin to run out of the bottom of the bottle.

### THE BALANCED STICK.

Procure a piece of wood about the length of your hand, half an inch thick, and twice as broad ; within a short distance of one end of this piece, thrust in the points of the blades of two penknives of equal weight, in such a manner, that one of them may incline to one side, the second to the other, as represented by the cut in the margin. If its other extremity be placed on the tip of the finger, the stick will keep itself upright without falling ; and if it be made to incline, it will raise itself again and recover its former situation. This is a very pretty performance, and if properly managed, cannot fail to excite some surprise in the minds of those who behold it for the first time, as the knives, instead of appearing to balance the stick, which they in fact do, will rather appear to increase the difficulty of the feat.



### STORM AND CALM.

Pour water into a glass until it is nearly three parts full ; then almost fill it up with oil ; but be sure to leave a little space between the oil and the top of the glass. Tie a bit of string round the glass, and fasten the two ends of another piece of string to it, one on each side, so that, when you take hold of the middle of it to lift up the glass, it may be about a foot from your hand. Now swing the glass to and fro, and the oil will be smooth and unruffled, while the surface of the water beneath it will be violently agitated.



## THE DOUBLED COIN.

Half fill a glass with water, and put a coin into it ; cover the glass with a plate, upon which place one hand, while you hold the glass with the other ; turn the glass upside down, so that none of the water may escape ; place it on a table, and you will see the coin at the bottom larger than it is in reality, and another will appear, of the natural size, a little above it.

## THE TOPER'S TRIPOD.

A trick similar to the Bridge of Knives may be performed by three tobacco-pipes, in the following manner :—Procure three common tobacco-pipes ; place the hollow part of



the bowl of one of them on the table, as No 1, and let its stem be supported by another, placed at No. 2 ; then put the other pipe across Nos. 1 and 2 (as No. 3), so that its bowl end may support the stem of No. 2, and its own stem rest on the bowl end to No. 3. This little tripod, although constructed of such brittle materials, will, if carefully put together, support a jug of foaming Lager. When used to show that it will support a weight, the three bowls should be brought considerably closer together than as represented in the marginal cut, so that the bottom of the jug may rest upon all three of the stems.

## THE COUNTER CHANGED.

Take two papers, three inches square each, divided into two folds, of three equal parts on each side, so as each folded paper remains one inch square ; then glue the back part of the two together, as they are folded, and not as they are opened, so that both papers seem to be but one, and which side

soever you open, it may appear to be the same ; if you have a dime in one hand, and a counter in the other, show one, and you may, by turning the paper, seem to change it.

### THE PRANCING DRAGOON.

Cut out the figure of a dragoon, mounted, in wood ; let the horse be in a prancing position : put the hind legs on the edge of a table, and it will, of course, fall off ; but you can prevent it from so doing, by adding to its weight. For this purpose, you must have a little hole made in the centre of the belly, into which run one end of a piece of wire, so bent backward, that the other end of it, to which a weight is fixed, may be under the table. The Dragoon will not only stand safe, but you may put him in motion, and he will prance up and down, without there being the least danger of his falling. The wire should be considerably longer in proportion to the size of the horse than is represented in the engraving in the margin, if you wish the figure to come much below the edge of the table when prancing. If it be no longer than that shown in the cut, the horse's fore-legs can only descend to a distance equal to that between the weight at the end of the wire, and the bottom of the table on which the figure is set. In fact, the Dragoon may be made to descend lower, and rise higher, in proportion to the length of the wire, if it be properly curved and fixed in the figure.



### THE BOWING BEAU.

Make a figure, resembling a man, of any substance, exceedingly light, such as the pith of the alder tree, which is

soft, and can easily be cut into any form ; then provide for it an hemispherical base, of some very heavy substance,



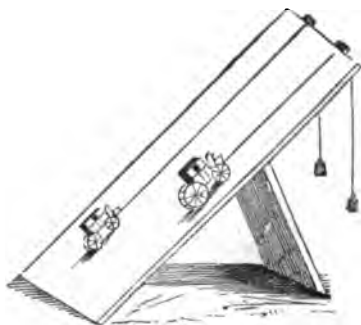
such as the half of a leaden bullet, made very smooth on the convex part. Cement the figure to the plane part of the hemisphere ; and, in whatever position it is placed, when left to itself, it will rise upright. In this manner were constructed those small figures, called Prussians, sold at Paris : they were formed into battalions, and being made to fall down, by drawing a rod over them, they immediately started up again as soon as it was removed. We think that

the figure of a beau, or master of the ceremonies, is much more appropriate for this trick than that of a soldier, as the latter seldom bows, while by the former the most profound inclinations are often performed. By moving it once downward a succession of bows may be produced.

#### THE WIZARD'S CHARIOT.

This trick will call your mechanical abilities into play. First, get a piece of board, planed quite smooth ; fasten a cross-piece under it, to support it in the position indicated by the cut. At the upper edge of the slanted piece, fix two little pulleys, the use of which may, at a glance, be seen by the engraving. Next, construct two little coaches, carts, or classical triumphal chariots ; let the wheels of one of them be considerably larger than those of the other ; they must, however, be precisely the same weight, or, if not, you must load one with shot to make it equal, in this respect, to the other. Do your work so neatly, that the wheels of each may run equally well on their respective axles. Next provide two lumps of lead, which must tally with each other to a scruple, and be sufficiently heavy to pull the chariots up the plane. Fix a piece of thread to the front of each of

the chariots ; pass these threads through the pulleys, and fasten one of your weights to each of them. The threads, be it remarked, should be long enough only to reach from the chariot, when placed at the foot of the inclined boards, through the pulleys to the leads ; and the board should be so inclined that the distance from the pulleys to the ground be



precisely the same as that of the chariots to the pulleys. Your apparatus being thus ready, weigh the chariots together, and afterward the leads in the presence of the spectators, that they may be satisfied they are equal, and let them inspect your apparatus, to see that all is fair : then start your chariots, and, notwithstanding the equality of their weights, and the equality of those of the leads, one of them will considerably outstrip the other ; the chariot with the highest wheels will always be the winner of the race. This mechanical truth is unknown to many, and may if properly managed, produce much surprise.

#### THE SIMPLE DECEPTION.

Stick a little wax upon your thumb, take a by-stander by the fingers, show him a dime, and tell him you will put the same into his hand ; then wring it down hard with your waxed thumb, and using many words, look him in the face ; suddenly take away your thumb, and the coin will adhere to it ; then close his hand ; it will seem to him that the dime remains ; now tell him to open his hand, and, if you perform

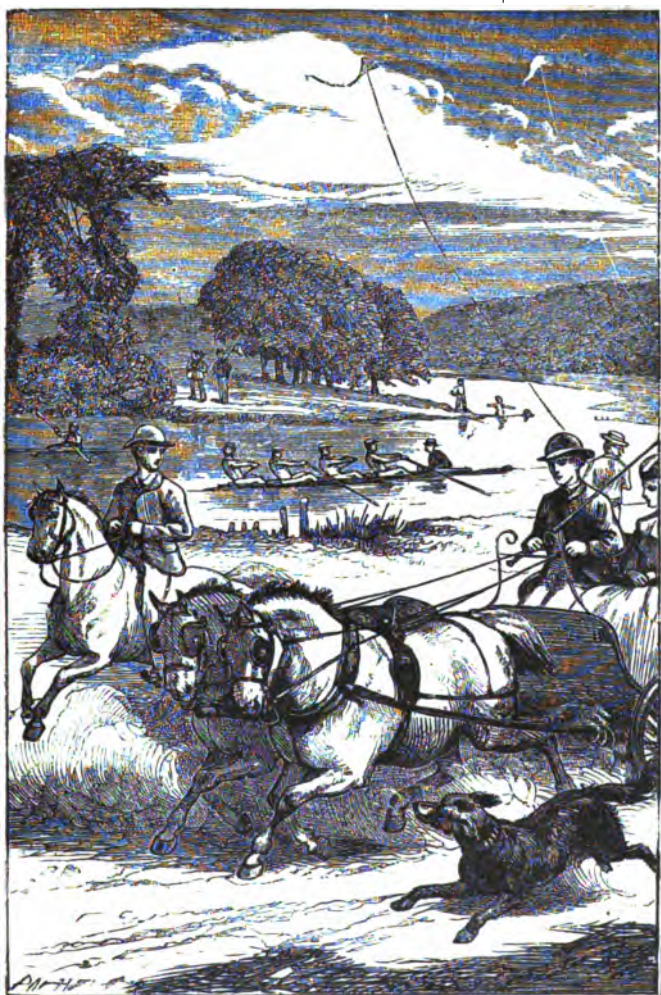
the feat cleverly, to his great astonishment, he will find nothing in it.



### *THE AUTOMATIC CHESS-PLAYER.*

#### PHILOSOPHY CHEATED.

This feat is really an excellent one, and has astonished crowds of spectators in London and different parts of the United States. It was one of the favorites of a late popular professor, and is now first promulgated. Before you perform it in public, you must practice it until you are quite perfect, in private, for it would be a pity to spoil its effect by making a blunder in it. Begin by stating very seriously, what is a well-known fact, that if a bucket full of water be hurled round his head by a man, who is sufficiently strong, none of the water will fall out. If this be at all discredited, be prepared not only to support your assertion, but to carry the point still further, by placing a tumbler full of any liquid in the inside of a broad hoop, which you hold in your hand by a small piece of string fixed to it, and twirling it round at your side. If you do this with velocity, although the tumbler, in the circles made by the hoop, is frequently quite bottom upward, it will neither fall from the hoop, nor will any of the water be spilt. To do this, however, requires even more practice than the trick which it prefaces; as, although there is no difficulty in it while





the hoop is in rapid motion, yet there is some danger until you are rendered expert by practice, of the tumbler's falling when you begin to put the hoop in motion, and when you wish to stop it. If, therefore, you are not perfectly capable of doing it, state the fact only, which some or other of your auditors will most probably support, as it is pretty generally known. You now go on to say that the air under the water in the glass, when it is topsy-turvy, keeps it in; and that, upon the same principle, if you can turn your hand, upon which you place a piece of thin wood (about one inch broad and six inches long) sufficiently quick, although the back be uppermost, the air will actually keep the wood up against the palm of your hand, without any support.

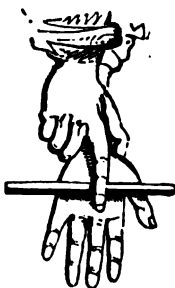
This they will be readily inclined to believe; the more philosophical the party is, the more easily may you lead them to credit your assertion. They will, however, doubt your being possessed of sufficient manual dexterity to perform it quick enough.

We must now tell you how it is to be done:—Lay the piece of wood across the palm of your left hand, which keep wide open, with the thumb and all the fingers far a part, lest you be suspected of supporting the wood with them. Next, take your left wrist in your right hand, and grasp it tightly, for the purpose, as you state, of giving the hand more steadiness. Now, suddenly turn the back of your left hand uppermost, and, as your wrist moves in your right hand, stretch out the forefinger of your right hand, and as soon as the wood comes undermost, support it with such forefinger. You may now shake the hand, and, after a moment or two, suffer the wood to drop. It is two to one but the spectators will admit it to be produced by the action of the air, as you had previously stated, and try to do it themselves; but, of course,





they must, unless you have performed the feat so awkwardly as to be discovered, fail in its performance. If you



have no objection to reveal the secret, you can do it again, and while they are gravely philosophizing upon it suddenly lift up your hand (*vide cut*) and expose the trick. This will doubtless create much amusement. Observe that in doing this feat, you must keep your fingers so low that no one can see the palm of your left hand; and move your finger so carefully, that its action may not be detected; and if it be not, you may rest satisfied that its absence from round the

wrist of the left hand will not be discovered, some of the fingers being naturally supposed to be under the coat; so that, if the spectators only see two or even one, they will imagine the others are beneath the cuff. There is one other observation necessary before we conclude; it is this: When you have turned your hand over, do not keep the stick too long upheld, lest the spectators should take hold of your hands and discover the trick; before their astonishment has ceased, adroitly remove your forefinger, and suffer the stick to fall to the ground.





## PART II.

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### PHILOSOPHY IN SPORT

MADE

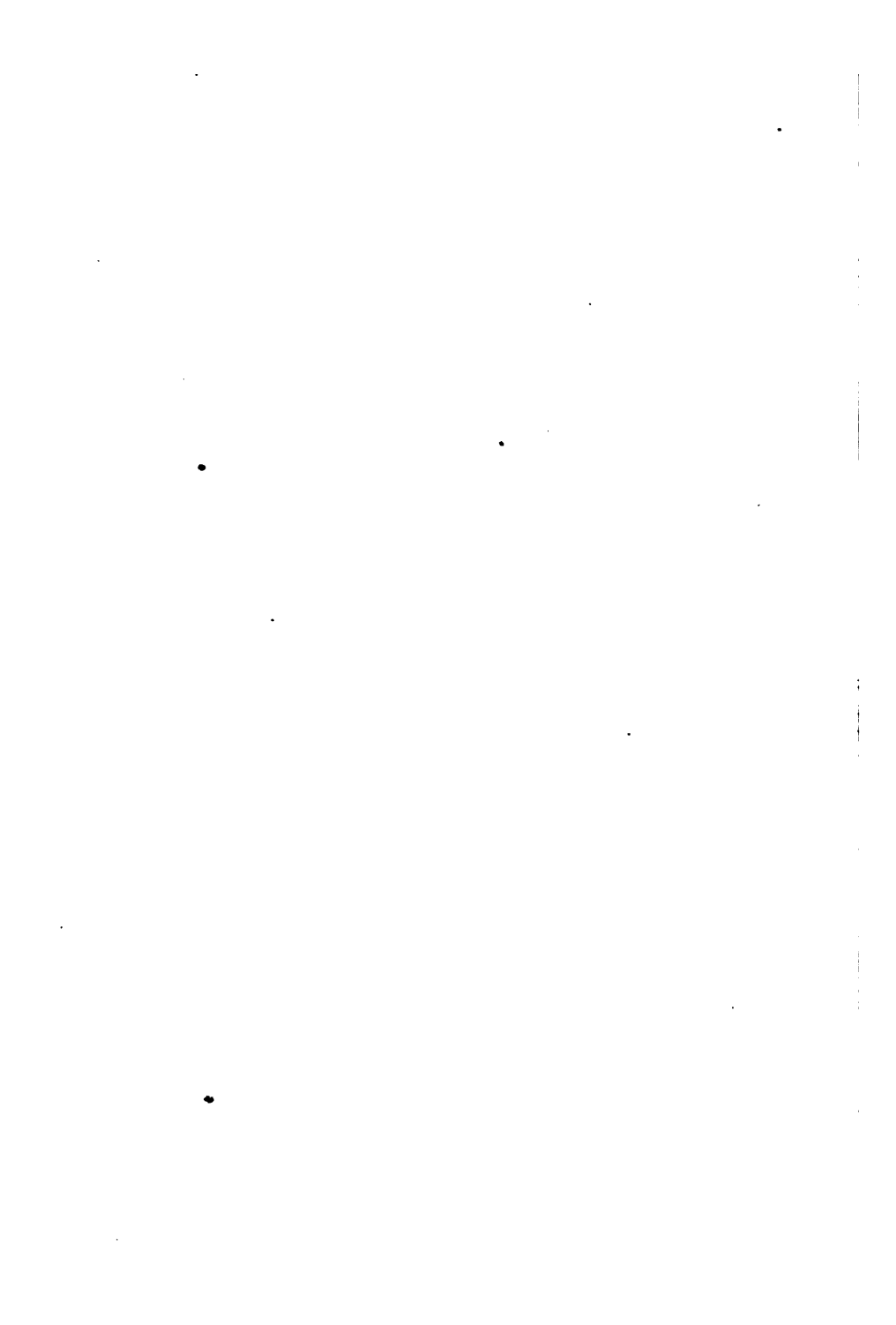
### SCIENCE IN EARNEST.

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'Tis not enough that Greek and Roman page  
At stated hours the sprightly boy engage ;  
E'en in his pastimes he requires a friend,  
To warn, and teach him safely to unbend :  
And levying thus, and with an easy sway,  
A tax of profit from his very play,  
To impress a value, not to be erased,  
On moments, squandered else, and running all  
to waste.

COWPER'S *Tirocinium*.

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## INTRODUCTION TO PART II.

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Now, my dear boys, having given you in the preceding part the rules and regulations for an infinite number of games, to amuse you through the summer and winter months, if you will give me your attention, by following me through this, the second part of our book, I will endeavor to give you a little instruction as well as amusement, by informing you how certain things occur. This I propose to do in the way of conversations held between a gentleman and his family. So I must ask you to indulge me so far as to try the scheme I have hit upon, by which I hope to turn "SPORT INTO SCIENCE;" or, in other words, *Toys* into instruments of *Philosophical Instruction*.

In the first place, I will give you some general notions with regard to the properties of matter, such as its gravitation, elasticity, the velocity of falling bodies, why a top spins, the kite will soar in the air, and a fly can walk up the window.

What apparatus can be required for such a purpose, beyond some of the more simple toys? Indeed, I will undertake to demonstrate the three grand laws of motion by a game at ball; while the composition and resolution of forces may be beautifully exemplified during a game of marbles, especially that of 'ring-taw;' but in order that you may more clearly comprehend the capability of my plan, allow me to enumerate the various philosophical principles which are involved in the operation of the several more popular toys and sports. We will commence with the ball; which will illustrate the nature and phenomena of *elasticity*, as it leaps from the ground;—of *rotatory motion*, while it runs along its surface;—of *reflected motion*, and of the *angles of incidence and reflection*, as it rebounds from the wall; and of *projectiles*, as it is whirled through the air; at the same time the cricket-bat may serve to explain the *center of percussion*. A game at marbles may be made subservient to the same purposes, and will further assist us in conveying clear ideas upon the subject of the *collision of elastic and non-elastic bodies*, and of their *velocities and direction after impact*. The *composition and resolution of forces* may be explained at the same time. The nature of *elastic springs* will require no other apparatus for its elucidation than Jack-in-the-box and the numerous leaping-frogs and cats with which the play-room abounds. The leathern sucker will exemplify the nature of *cohesion*, and the effect of water in filling up those inequalities by which contiguous surfaces are deprived of their attractive power; it will, at the same time, demonstrate the nature of a *vacuum*, and the influence of *atmospheric pressure*. The squirt will afford a further illustration of the same views, and will furnish a practical proof of the weight of the atmosphere in raising a column of water. The theory of the pump will necessarily follow. The greater elasticity of air compared with that of water, I shall be able to show by the amusing exhibition of the '*Bottle Imps*.'

"Bottle Imps!—*Acheronta movebis!*" muttered the vicar.

Mr. Seymour continued—"The various balancing toys will

elucidate the nature of the *center of gravity*, *point of suspension*, and *line of direction*; the see-saw, rocking-horse, and the operation of walking on stilts, will here come in aid of our explanations. The combined effects of momentum and a change in the center of gravity of a body may be beautifully exemplified by the action of the Chinese Tumblers. The sling will demonstrate the existence and effect of *centrifugal force*, and humble and finite as the alliance may seem, it will satisfactorily explain the motions of those celestial orbs that revolve to all eternity around a central sun. The top\* and tee-totum will prove the power of whirling motion to support the axis of a body in an unaltered position. The trundling of the hoop will accomplish the same and other objects; as will also the whirling of the *quoit*, with the additional advantage of not having its motions impeded by contact with the ground. The game of *bilboquet*, or cup and ball, will show the influence of rotatory motion in steadying the rectilinear path of a spherical body, whence the theory of the rifle-gun may be deduced. For conveying some elementary ideas of the doctrine of *oscillation*, there is the swing. The flight of the arrow will not only elucidate the principles of *projectiles*, but will explain the force of the air in producing rotatory motion by its impact on oblique surfaces: the revolution of the shuttlecock may be shown to depend upon the same revolution of forces. Then comes the kite, one of the most instructive and amusing of all the pastimes of youth,—the favorite toy of Newton in his boyish days:†—its ascent at once develops the theory of the com-

\* "The motion of the top is a matter of the greatest importance. It is applicable to the elucidation of some of the greatest phenomena in nature."—*Airy's Lectures on Ipswich*.

† Sir Isaac Newton is said to have been much attached to philosophical sports when a boy; he was the first to introduce paper kites at Grantham, where he was at school. He took pains to find out their proper proportions and figure, and the proper place for fixing the string to them. He made lanterns of paper crimped, which he used to go to school by in winter mornings with a candle, and he tied them to the tail of his kites in a dark night, which at first frightened the country people exceedingly, who took his candles for comets.—*Thompson's Hist. of R. S.*

position and resolution of forces, and explains various subordinate principles which I shall endeavor to describe when we arrive at the subject. The *see-saw* will unfold the general principle upon which the Mechanical Powers are founded; and the boy may thus be easily led to the theory of the *lever*, by being shown how readily he can balance the heavier weight of a man by riding on the longer arm of a plank. The theory of colors may be pointed out to him as he blows his soap-bubbles;\* an amusement which will, at the same time, convince him that the air must exert a pressure equally in all directions. For explaining the theory of sound, there are the whistle, the humming-top, the whiz-gig, the pop-gun, the bull-roarer, and sundry other amusements well known in the playground; but it is not my intention, at present to enumerate *all* the toys which may be rendered capable of affording philosophical instruction; I merely wish to convince you that my plan is not quite so chimerical as you were at first inclined to believe. I do not profess to place the head of Laertes on the shoulders of Telemachus, nor, like Friar Bacon, to teach the science of the age in half a year; but I do engage to teach the young student those rudiments by which, with diligence and a willing mind, he may ultimately acquire it."

"Upon my word," said the vicar, "no squirrel ever hopped from branch to branch with more agility; you are the very counterpart of Cornelius Scriblerus; but I must confess that your scheme is plausible, very plausible, and I shall no longer refuse to attend you in the progress of its execution.

\* The colors which glitter on a soap-bubble are the immediate consequence of a principle the most important from the variety of phenomena it explains, and the most beautiful from its simplicity and compendious neatness in the whole science of Optics.—*Herschel's Preliminary Discourse*. In a future part of this work it will be seen that the soap-bubble enabled Faraday to carry out a most important series of experiments.

# PHILOSOPHY IN SPORT.



## CHAPTER I.

ON GRAVITATION.—WEIGHT.—THE VELOCITY OF FALLING BODIES.—AT WHAT ALTITUDE A BODY WOULD LOSE ITS GRAVITY.—THE TOWER OF BABEL.—THE KNOWN VELOCITY OF SOUND AFFORDS THE MEANS OF CALCULATING DISTANCES.—THE SOUND OF THE WOODMAN'S AXE.—AN EXCURSION TO OVERTON WELL.—AN EXPERIMENT TO ASCERTAIN ITS DEPTH.—MOTION—ABSOLUTE AND RELATIVE.—UNIFORM, ACCELERATED, AND RETARDED VELOCITY.—THE TIMES OF ASCENT AND DESCENT ARE EQUAL.—VIS INERTIA.—FRICTION.—ACTION AND REACTION ARE EQUAL AND IN OPPOSITE DIRECTIONS.—MOMENTUM DEFINED AND EXPLAINED.—THE THREE GREAT LAWS OF MOTION.

It was about two o'clock, when Mr. Twaddleton, in company with Mr. and Mrs. Seymour, joined the children on the lawn.

"Tom," said the father, "are you prepared to commence the proposed examination?"

"Quite ready, papa."

"Then you must first inform me," said Mr. Seymour, tak-



ing the ball out of Rosa's hand, "why this ball falls to the ground as soon as I withdraw from it the support of my hand."

"Because every *heavy* body that is not supported must of course fall."

"And every *light* one also, my dear; but that is no answer to my question: you merely assert the fact, without explaining the reason."

"Oh! now I understand you; it is owing to the force of gravity; the earth attracts the ball, and the consequence is that they both come in contact; is not that right?"

"Certainly; but if the earth attract the ball, it is equally true that the ball must attract the earth; for you have, doubtless, learned that bodies mutually attract each other; tell me, therefore, why the earth should not rise to meet the ball?"

"Because the earth is so much larger and heavier than the ball."

"It is, doubtless, much larger; and since the force of attraction is in proportion to the mass, or quantity of matter you cannot be surprised at not perceiving the earth rise to meet the ball, the attraction of the latter being so infinitely small, in comparison with that of the former, as to render its effect wholly nugatory; but, with regard to the earth being heavier than the ball, what will you say when I tell you that, in the ordinary acceptance of the term, it cannot be said to have any weight?"

"No weight at all?"

Tom begged that his father would explain to him how it could possibly be that the earth should not possess any weight.

"Weight, my dear boy, you will readily understand, can be nothing more than an effect arising out of the resisted attraction of a body for the earth: you have just stated that all bodies have a tendency to fall, in consequence of the attraction of gravitation; but if they be supported, and prevented from approaching the earth, either by the hand or any other appropriate means, this tendency will be felt, and is called *weight*."

Tom understood this explanation, and observed, that "since attraction was always in proportion to the quantity of matter, so, of course, a larger body must be more powerfully attracted, or be *heavier*, than a smaller one."

"Magnitude, or size, my dear, has nothing whatever to do with quantity of matter: will not a small piece of lead weigh more than a large piece of sponge? In the one case, the particles of matter may be supposed to be packed in a smaller compass; in the other, there must exist a greater number of pores or interstices."

"I understand all you have said," observed Louisa, "and yet I am unable to comprehend why the earth cannot be said to have any weight."

"Cannot you discover," answered Mr. Seymour, "that since the earth has nothing to attract it, it cannot have any attraction to resist, and consequently, according to the ordinary acceptation of the term, it cannot be correctly said to possess weight? although I confess that, when viewed in relation to the solar system, a question will arise upon this subject, since it is attracted by the sun."

The children declared themselves satisfied with this explanation, and Mr. Seymour proceeded to put another question: "Since," continued he, "you now understand the nature of that force by which bodies fall to the earth, can you tell me the degree of velocity with which they fall?"

Tom asserted that the weight of the body, or its quantity of matter, and its distance from the surface of the earth, must, in every case, determine that circumstance; but Mr. Seymour excited his surprise by saying that it would not be influenced by either of those conditions; he informed them, for instance, that a cannon-ball and a marble would fall through the same number of feet in a given time, and that, whether the experiment were tried from the top of a house or from the summit of St. Paul's, the same result would be obtained.

"I am quite sure," exclaimed Tom, "that in the *Conversations on Natural Philosophy*, it is positively stated, that

*attraction is always in proportion to the quantity of matter."*

"Yes," observed Louisa, "and it is moreover asserted, that the attraction diminishes as the distances increase."

Mr. Seymour said, that he perceived the error under which his children labored, and that he would endeavor to remove it. "You cannot, my dears," continued he, "divest your minds of that erroneous but natural feeling, that a body necessarily falls to the ground without the exertion of any force: whereas, the greater the quantity of matter, the greater must be the force exerted to bring it to the earth: for instance, a substance which weighs a hundred pounds will thus require just ten times more force than one which only weighs ten pounds; and hence it must follow, that both will come to the ground at the same moment; for although, in the one case, there is ten times more matter, there is, at the same time, ten times more attraction to overcome its resistance; for you have already admitted that the force of attraction is always in proportion to the quantity of matter. Now let us only for an instant, for the sake merely of argument, suppose that attraction had been a force acting without any regard to quantity of matter, is it not evident that, in such a case, the body containing the largest quantity would be the slowest in falling to the earth?"

"I understand you, papa," cried Tom: "if an empty wagon traveled four miles an hour, and were afterward so loaded as to have its weight doubled, it could only travel at the rate of two miles in the same period, provided that in both cases the horses exerted the same strength."

"Exactly," said Mr. Seymour; "and to follow up your illustration, which is not a bad one, it is only necessary to state, that Nature, like a considerate master, always apporions the number of horses to the burden that is to be moved, so that her loads, whatever may be their weight, always travel at the same rate; or, to express the fact in philosophical instead of figurative language, gravitation, or the force of the earth's attraction, always increases as the

quantity of matter, and, consequently, that heavy and light bodies, when dropped together from the same altitude, must come to the ground at the same instant of time."

Louisa had listened with great attention to this explanation; and although she thoroughly understood the argument, yet it appeared to her at variance with so many facts with which she was acquainted, that she could not give implicit credence to it.

"I think, papa," said the archly smiling girl, "I could overturn this fine argument by a very simple experiment."

"Indeed, Miss Skeptic: then pray proceed; and I think we shall find that the more strenuously you oppose it the more powerful it will become; but let us hear your objections."

"I shall only," replied she, "drop a shilling and a piece of paper from my bed-room window upon the lawn, and request that you will observe which of them reaches the ground first; if I am not much mistaken, you will find that the coin will strike the earth before the paper has performed half its journey."

Tom appeared perplexed, and cast an inquiring look at his father.

"Come," said Mr. Seymour, "I will perform this experiment myself, and endeavor to satisfy the doubts of our young skeptic; but I must first take the opportunity to observe that I am never better pleased than when you attempt to raise difficulties in my way, and I hope you will always express them without reserve."

"Here, then, is a penny-piece; and here," said Tom, "is a piece of paper."

"Which," continued Mr. Seymour, "we will cut into a corresponding shape and size." This having been accomplished, he held the coin in one hand and the paper disk in the other, and dropped them at the same instant.

"There! there!" cried Louisa, with an air of triumph; "the coin reached the ground long before the paper."

Mr. Seymour allowed that there was a distinct interval in

favor of the penny-piece; and he proceeded to explain the cause of it. He stated that the result was not contrary to the law of gravitation, since it arose from the interference of a foreign body, the air, to the resistance of which it was to be attributed: and he desired them to consider the particles of a falling body as being under the influence of two opposing forces,—gravity and the air's resistance. Louisa argued, that the air could only act on the surface of a body, and as this was equal in both cases (the size of the paper being exactly the same as that of the penny-piece), she could not see why the resistance of the air should not also be equal in both cases.

"I admit," said Mr. Seymour, "that the air can only act upon the surface of a falling body, and this is the very reason of the paper meeting with more resistance than the coin; for the latter, from its greater density, must contain many more particles than the paper, and upon which the air cannot possibly exert any action; whereas almost every particle of the paper may be said to be exposed to its resistance, the fall of the latter must therefore be more retarded than that of the former body."

At this explanation Louisa's doubts began to clear off, and they were ultimately dispelled on Mr. Seymour performing a modification of the above experiment in the following manner. He placed the disk of paper in close contact with the upper part of the coin, and, in this position, dropped them from his hand. They both reached the ground at the same instant.

"Are you now satisfied, my dear Louisa?" asked her father: "you perceive that, by placing the paper in contact with the coin, I screened it from the action of the air, and the result is surely conclusive."

"Many thanks to you, dear papa; I am perfectly satisfied, and shall feel less confident for the future." Tom was delighted; for, as he said, he could now understand why John's *parachute* descended so deliberately to the ground; he could also explain why feathers, and other light bodies, floated in the air. "Well then," said Mr. Seymour, "having settled

this knotty point, let us proceed to the other question, viz.: 'that a body will fall with the same velocity, during a given number of feet, from the ball of St. Paul's as from the top of a house.' You maintain, I believe, that, since the attraction of the earth for a body diminishes as its distance from it increases,\* a substance at a great height ought to fall more slowly than one which is dropped from a less altitude."

Neither Tom nor Louisa could think otherwise. Mr. Seymour told them that, *in theory*, they were perfectly correct, but that, since attraction acted from the center, and not from the surface of the earth, the difference of its force could not be discovered at the small elevations to which they could have access: "for what," said he, "can a few hundred feet be in comparison with four thousand miles, which is the distance from the center to the surface of our globe? You must therefore perceive that, in all ordinary calculations respecting the velocity of falling bodies, we may safely exclude such a consideration."

"But suppose," said Tom, "it were possible to make the experiment a thousand miles above the earth, would not the diminished effect of gravity be discovered in that case?"

"Undoubtedly; indeed it would be sensible at a much less distance: for instance, if a lump of lead, weighing a thousand pounds, were carried up only four miles, it would be found to have lost two pounds of its weight."

"This discussion," observed Mr. Twaddleton, "reminds me of a problem that was once proposed at Cambridge, to find the elevation to which the Tower of Babel could have been raised, before the stones would have entirely lost their gravity."

"Its solution," said Mr. Seymour, "would require a con-

\* Gravity, or the tendency of a body to approach the earth, is inversely as the *square of the distance*; that is, if a body be attracted by the earth at a certain distance, with a certain force, and be afterwards removed to *twice* the distance, it will now be attracted not *half* as much, but only *one-fourth* as much as it was before; and if it be removed to *three* times the first distance, it will be attracted, not *one-third* as much, but *one-ninth*, as much as before four being the square of two, and nine the square of three; and so on.

sideration which Tom could not possibly understand at present, viz., the influence of the *centrifugal force*."

"I am fully aware of it," replied the vicar, "and in order to appreciate that influence, it would, of course, be necessary to take into account the latitude of the place; but, if my memory serves me, I think that under the latitude of 30°, which, I believe, is nearly that of the plains of Mesopotamia, the height would be somewhere about twenty-four thousand miles."

Mr. Seymour now desired Tom to inform him, since all bodies fall with the *same* velocity, what that velocity might be.

"Sixteen feet in a second, papa. I have just remembered that I had a dispute with a schoolfellow upon that subject, and in which, thanks to Mrs. Marcet, I came off victorious, and won twelve marbles."

"Then let me tell you, my fine fellow, that, unless your answer exclusively related to the *first* second of time, you did not win the marbles fairly; for, since the force of gravity is continually acting, so is the velocity of a falling body continually increasing, or it has what is termed an '*accelerating velocity*;' it has accordingly been ascertained by accurate experiments, that a body descending from a considerable height falls sixteen feet, as you say, in the *first* second of time; but *three times sixteen* in the next; *five times sixteen* in the third; and *seven times sixteen* in the fourth; and so on, continually increasing according to the odd numbers, 1, 3, 5, 7, 9, 11, &c.: so that you perceive," continued Mr. Seymour, "by observing the number of seconds which a stone requires to descend from any height, we can discover the altitude or depth of the place in question."

Louisa and Fanny, who had been attentively listening to their father's explanation, interchanged a smile of satisfaction, and, pulling Tom toward them, whispered something which was inaudible to the rest of the party.

"Come, now," exclaimed Mr. Seymour, "I perceive by your looks that you have something to ask of me: is Louisa skeptical again?"

"Oh dear no," replied Tom; "Louisa merely observed that we might now be able to find out the depth of the village well, about which we have all been very curious; for the gardener has told us that it is the deepest in the kingdom, and was dug more than a hundred years ago."

Mr. Seymour did not believe that it was the deepest in the kingdom, although he knew that its depth was considerable; and he said that if Mr. Twaddleton had no objection, they should walk to it, and make the proposed experiment.

"Objection! my dear Mr. Seymour, when do I ever object to afford pleasure to my little playmates, provided its indulgence be harmless? much less when it is associated with instruction. The old adage tells us that 'Truth lies at the bottom of a well,' so let us proceed at once to invade her retreat, and extort her secrets; and on our return I hope you will favor me with a visit at the vicarage. I have some antiquities which I am anxious to exhibit to yourself and Mrs. Seymour." Tom and Rosa each took the vicar's hand, and Mr. and Mrs. Seymour followed with Louisa and Fanny. The village well was about half a mile distant; the road to it led through a delightful shady lane, at the top of which stood the vicarage-house. Mr. and Mrs. Seymour and her daughters had lingered in their way to collect botanical specimens; and when they had come up to Tom and the vicar, they found them seated on the trunk of a newly felled oak in deep discourse.

"What interests you, Tom?" said Mr. Seymour, who perceived, by the inquiring and animated countenance of the boy, that his attention had been excited by some occurrence.

"I have been watching the woodman, and have been surprised that the sound of his hatchet was not heard until some time after he had struck the tree."

"And has not Mr. Twaddleton explained to you the reason of it?"

"He has," replied Tom, "and he tells me that it is owing to sound traveling so much more slowly than light."

"You are quite right; and, as we are upon an expedition for the purpose of measuring depths, it may not be amiss to



inform you that this fact furnishes another method of calculating distances."

The party seated themselves upon the oak, and Mr. Seymour proceeded:—"The stroke of the axe is seen at the moment the woodman makes it, on account of the immense velocity with which light travels; (1\*) but the noise of the blow will not reach the ear until some time has elapsed, the period varying, of course, in proportion to the distance, because sound moves only at the rate of 1142 feet in a second, or about 13 miles in a minute: so that you perceive, by observing the time that elapses between the fall of the hatchet and the sound produced by it, we can ascertain the distance of the object."

Mr. Seymour fixed his eye attentively on the woodman, and, after a short pause, declared that he was about half a quarter of a mile distant.

"Why, how could you discover that?" cried Louisa; "you had not any watch in your hand."

"But you might have perceived that I placed my finger on my wrist, and, as my pulse beats about 75 strokes in a minute,† I was able to form a tolerable estimate of the interval, although I confess that it is a very rough experiment, but sufficiently accurate for the purpose of illustration. In the same manner, we can readily ascertain the distance of a thunder-cloud, or that of a vessel at sea firing a cannon. If we do not hear the thunder till half a minute after we see the lightning, we are to conclude the cloud to be at the distance of six miles and a half. But let us proceed to the well."

After a walk of a few minutes, the party reached the place of destination. On their arrival, Mr. Seymour inquired who would count the time.

"Be that office mine," said Mr. Twaddleton, as he extracted a large silver time-piece from the dark abyss of his watch-pocket; "and let Tom," continued he, "find a pebble."

\* These figures refer to the additional notes at the end of the work.

† The pulse was the measure of time used by Galileo in his celebrated experiments.

"Here is one," cried Louisa.

"Very well: now, then, how will you proceed?" asked Mr. Seymour.

"I shall drop the stone," replied Tom, "into the well, and observe how many seconds it will be before it touches the water, and I shall then set down the number of feet it will fall in each second, and add up the numbers."

"That," said Mr. Seymour, "would certainly accomplish your object; but I can give you a neater, as well as a shorter rule for performing the sum; you shall, however, first work it in your own way;—but you have not yet informed me how you propose to ascertain the moment at which the stone reaches the water."

"By the sound, to be sure, and you will find that a very loud one will be produced."

"If the depth of the well be considerable, such a plan will not answer the purpose, since, in that case, there must necessarily be a perceptible interval between the fall of the stone and the sound produced by it, as you have just seen exemplified by the woodman, which, unless taken into account, will vitiate the result."

Tom observed that he had not thought of that difficulty, and did not know how he could get over it. His father told him, that he must look at the surface of the water, and mark the moment it was disturbed by the stone.

"Now, Mr. Twaddleton," said Mr. Seymour, "are you ready to count the seconds?"

"Quite ready."

"Then drop the stone."

"One,—two,—three,—four—"

"There," said Tom, "it touched the water."

"And there, there," cried several voices, "what a noise it made!"

"*Facilis descensus Averni*," exclaimed the vicar; "the stone descended in four seconds."

"Now, my boy, make your calculation."

Mr. Seymour furnished pencil and paper, and Tom pro-

ceeded;—"Sixteen feet for the first second,—I put that down."

"Well," said his father, "and *three times sixteen* for the second?"

"*Forty-eight*," cried Tom.

"Put it down."

"*Five times sixteen* for the third?"

"*Eighty*."

"Down with it."

"And *seven times sixteen* for the fourth?"

"*One hundred and twelve*."

"Now, cast up these numbers," said Mr. Seymour.

"*Two hundred and fifty-six feet*," cried Tom, "is the depth of the well."

A shout of delight, from the whole juvenile party announced the satisfaction which they felt at the success of their first experiment in NATURAL PHILOSOPHY.

Louisa observed, that she could not distinguish any interval between the actual contact of the stone with the water and the sound which it produced.

"At so small a distance as two hundred and fifty-six feet," said her father, "the interval could not have exceeded in duration the fourth part of a second, and was, consequently, imperceptible: we might therefore, in the present instance, have accepted the sound as a signal of the stone's arrival at the water, without prejudice to the result of the experiment."

Mr. Seymour told his son, that the method which he had pursued was unobjectionable when the experiment did not extend beyond a few seconds; but that if a case occurred in which a greater space of time were consumed, he would find his plan tedious: "Now I will give you a general rule that will enable you to obtain the answer in a shorter time without the details of addition. '*The spaces described by a falling body increase as the squares of the times increase.*' I conclude that you already know that the *squares* of a number is the sum obtained by multiplying the number into itself."

"Certainly," answered Tom; "the square of four is 16; that of 8, 9, and so on."

"This, then, being the case, you have only to square the number of seconds, and then multiply that product by 16, being the space described by the falling body in the first second, and you will have the required answer: apply this rule to the present case; the stone fell to the bottom in four seconds; square this number,  $4 \times 4 = 16$ ; multiply this by 16, and we obtain 256."

"That," said Tom, "is certainly much more simple than my method."

"And it has the advantage," continued Mr. Seymour, "of being more portable for the memory."

"What honors, now, shall we decree to Tom's ball, if it instructs us in the first principles of philosophy?" observed Mr. Seymour, as he took the ball from Tom's hand, and rolling it along the ground, exclaimed, "There it goes, performing, as you may perceive, two different kinds of motion at the same time: it turns round, or revolves on its *axis*; and goes straight forward, or, to speak more philosophically, performs a *rectilinear* motion."

Tom said he did not exactly comprehend what was meant by the *axis*. His father, therefore, informed him that the axis of a revolving body was an imaginary line, which was itself at rest, but about which all its other parts turned or rotated. "But," continued he, "can you tell me whether you understand what is meant by the word *motion*?"

"Your ancient acquaintances," observed Mr. Seymour, "entertained some very strange notions touching this said subject of motion. If I remember right, Diodorus denied its very existence; but we are told that he did not himself remain *unmoved* when he dislocated his shoulder, and the surgeon kept him in torture, while he endeavored to convince him, by his own mode of reasoning, that the bone could not have moved out of its place. We have, however, at present, nothing to do with the ancients; the philosophers of our own times agree

in defining motion to be '*the act of a body changing its situation with regard to any other*;' and you will therefore readily perceive that this may actually happen to a body while it remains absolutely at rest."

"Well, that beats all the paradoxes I ever heard," cried Tom; "a body then may be in motion, while it is at rest."

"Certainly," replied Mr. Seymour, "it may be *relatively* in motion, while it is *absolutely* at rest."

"How can a body change its place," said Louisa, "except by moving?"

"Very readily," answered her father; "it may have its relative situation changed with respect to surrounding objects. There is your ball, and here is a stone; has not each of them a particular situation with respect to the other; and by moving one, do I not change the *relative* situation of both?"

"I perceive your meaning," said Tom.

"To prevent confusion, therefore, in our ideas, it became necessary to distinguish these two kinds of motion from each other by appropriate terms; and, accordingly, where there has been an actual change of place, in the common meaning of the term, the motion which produced it is termed **ABSOLUTE** motion; whereas, on the contrary, when the situation has been only relatively changed, by an alteration in the position of surrounding bodies, the motion is said to be **RELATIVE**."

"Surely, papa," said Louisa, "no person can ever mistake *relative* for *absolute* motion; what then is the use of such frivolous distinctions? When a body really moves, we can observe it in the act of changing its place, and no difficulty can arise about the matter."

"Nothing, my dear, is more fallacious than our vision; the earth appears motionless, and the sun and stars *seem* as if they revolved round it; but it is scarcely necessary for me to inform you, that our globe is constantly moving with considerable velocity, while the sun remains at rest. Mr. Sadler, the famous aeronaut," continued Mr. Seymour, "informed me that he was never sensible of the motion of his balloon in any of his excursions, but that, as he ascended into the air, the earth al

ways appeared as if sinking beneath him, and as he descended, as if rising to meet him."

Mr. Twaddleton here observed that he had heard a very curious anecdote, when he was last in London, which fully confirmed the truth of Mr. Sadler's statement. "An aeronaut," said he, "whose name I cannot at this moment recollect, had recently published a map of his voyage, and, instead of proceeding in any one line of direction, his track absolutely appeared in the form of circles, connected with each other like the links of a chain: this occasioned considerable astonishment, and of course some speculation, until it was at length discovered that his apparent journey was to be attributed to the rotatory motion of the balloon, which the voyager, not feeling, had never suspected."

"And what," asked Tom, "could have been the reason of his not having felt the motion?"

His father explained to him, that we are only conscious of being in motion when the conveyance in which we are placed suffers some impediment in its progress. "If," said he, "you were to close your eyes, when sailing on calm water, with a steady breeze, you would not perceive that you were moving: for you could not *feel* the motion, and you could only *see* it by observing the change of place in the different objects on the shore; and then it would be almost impossible, without the aid of reason and experience, to believe that the shore itself was not in motion, and that you were at rest. I shall, however, be able to explain this subject more clearly by an optical toy which I have in preparation."

Mrs. Seymour here repeated the following passage from that interesting novel "Anastasius," which she observed was beautifully descriptive of the illusive appearance to which their papa had just referred:

"The gradually increasing breeze carried us rapidly out of the Straits of Ohio. The different objects on the shore—mountains, valleys, villages, and steeples—seemed in swift succession, first advancing to meet us, then halting an instant alongside our vessel, as if to greet us on our passage, and,

lastly, again gliding off with equal speed; till, launched into the open main, we saw the whole line of coast gradually dissolve in distant darkness."

"That is indeed a beautiful and very apposite illustration," said Mr. Seymour; "and I think Louisa will now admit that it is not quite so easy as she at first imagined to distinguish between *Absolute* and *Relative* motion."

As the children now understood what was meant by the term *Motion*, their father asked them whether they could tell him what produced it.

"I can make a body move by various means," answered Tom.

"But they may all be reduced to one," said Mr. Seymour; "viz., some exertion which is called *Force*; thus the *force* of my hand put your ball in motion; while gravitation was the *force* which made it fall to the earth; and I must, moreover, inform you that a body always moves in the direction of the force which impels it, and with a velocity, or rate of motion, which is proportional to its degree or strength; and, were there no other forces in action but that which originally produced the motion, the body would proceed onward in a right line, and with a *uniform* velocity forever."

"Forever!" exclaimed Louisa.

"Ay, my dear, *forever*: but we will discuss that question presently; you must first tell me whether you understand what is meant by *uniform* velocity."

"I suppose that *uniform* velocity is that which is regular, and of an equal rate throughout."

"Philosophers," replied her father, "call the motion of a body *uniform*, when it passes over equal spaces in equal times. Now, Tom, it is your turn to answer a question. Can you describe the meaning of the terms *Accelerated* and *Retarded* motion?"

"I conclude that motion is said to be *accelerated* when it moves every moment quicker and quicker, and to be *retarded* when it moves slower and slower."

"You are perfectly right; and gravity may either act in

occasioning the one or the other; our experiment at the well, this morning, afforded you an example of gravity producing a regularly accelerated motion. I did not fully explain the fact at the time, because I was desirous of avoiding too many new ideas at once; we must win our way slowly and cautiously through the mazes of philosophy: I will, however, now endeavor to give you as clear an explanation as the subject will allow. It is, I think, evident, that if at the moment you dropped the stone from your hand the force of gravity could have been suspended, it would have descended to the bottom of the well with a uniform velocity; because there could have been nothing either to accelerate or retard its motion. But this was not the case, for the power of gravity was in constant operation; and, if you keep this fact in mind, you will readily understand how the velocity became accelerated: for, suppose the impulse given by gravity to the stone, during the first instant of its descent, be equal to *one*, the next instant we shall find that an additional impulse gives the stone an additional velocity equal to *one*, so that the accumulated velocity is now equal to *two*; the following instant again increases the velocity to *three*, and so on, till the stone reaches the bottom."

Mr. Twaddleton observed, the fact might be shortly expressed by saying, that "the effects of preceding impulses must be added to subsequent velocities."

Mr. Seymour then remarked that the same explanation would apply to *retarded* velocity. "If," said he, "you throw a stone perpendicularly upward, the velocity will be as much *retarded*, as it was in the other case *accelerated*, by gravity; the consequence of which is, that it will be exactly the same length of time ascending that it was descending."

"I should have thought the very reverse," cried Louisa, "and that it would have fallen quicker than it rose."

"You have forgotten to take into account the force with which the stone is thrown upward, and which is destroyed by gravity before it begins to descend."

"Certainly," answered Louisa; "but the force given to a



stone in throwing it upward cannot always be equal to the force of gravity in bringing it down again; for the force of gravity is always the same, while the force given to the stone is entirely optional. I may throw it up gently or otherwise, as I please."

"If you throw it gently," said her father, "it will not rise high, and gravity will soon bring it down again; if you throw it with violence, it will rise much higher, and gravity will be longer in bringing it back to the ground. Suppose, for instance, that you throw it with a force that will make it rise only sixteen feet; in that case, you know, it will fall in one second of time. Now it is proved by experiment, that an impulse requisite to project a body sixteen feet upward will make it ascend that height in one second of time; here, then, the times of ascent and descent are equal. But, supposing it be required to throw a stone twice that height, the force must be proportionally greater. You see, then, that the impulse of projection, in throwing a body upward, is always equal to the action of the force of gravity during its descent; and that it is the greater or less distance to which the body rises that makes these two forces balance each other."

"Thank you, dear papa, for the pains you have taken in explaining this subject to us."

"Nay," replied Mr. Seymour, "bestow your thanks upon those to whom they are more justly due; Mrs. Marcet is entitled to the merit of this explanation; for I obtained it from her 'Conversations.' Before I quit this subject, I would just observe that, when we come to the consideration of the bow and arrow, you will, by the application of the law I have endeavored to expound, be enabled to ascertain the height to which your arrow may ascend, with the same facility as you discovered the depth of the well; for, since the times of ascent and descent are equal, you have only to determine the number of seconds which intervene between the instant at which the arrow quits the bow to that at which it falls to the ground, and, having them, to make the usual calculation. But let us proceed to another subject. Roll the ball hither,

Tom; roll the ball hither, I say! you stand as if you thought it would advance to us of its own accord."

"I know a little better than that, too," cried Tom; "no body can move without the application of some force."

"Nor stop, either," added Mr. Seymour, "when it is once in motion; for matter is equally indifferent to both rest and motion."

"And yet, papa," cried Louisa, "unfortunately for your assertion, the ball stopped just now, and I am sure that no force was used to make it do so."

"And pray, Miss Pert, why are you so sure that no force was opposed to its progress? I begin to fear that my lesson has been thrown away upon you, or you would not, surely, have concluded so falsely."

The vicar here interposed, observing that, simple as the question might appear to those who had studied it, the fact was so contrary to every thing that passed before us, that Mr. Seymour ought not to feel any surprise at the skepticism of his daughter; he begged to remind him that the truth, apparent as it doubtless now was, lay hid for ages before the sagacity of Galileo brought it to light.

Mr. Seymour admitted the justice of this remark, and proceeded in his explanation.

"I think," said he, "you will readily allow that matter cannot, in itself, possess any power of changing its condition: it can, therefore, no more destroy than it can originate its own motion; when it is at rest, it must ever remain so, unless some force be applied that can impart to it activity; and when once in motion, it must continue to move until some counteracting force stops it. To believe otherwise, you must suppose that matter possesses in itself a power to alter its condition, which is perfectly absurd."

"And yet," said Tom, "when I see my ball or marble stop of its own accord, how can you blame me for believing it possible?"

"Your difficulty arises from your ignorance of the existence of certain forces which act upon the rolling ball or mar-

ble. Its progress, as it rolls along, is impeded and ultimately stopped by the rubbing, or friction, occasioned by its passage over the ground; and this will be greater or less, according to the degree of roughness of the surface; if it be small, the ball will continue for a longer time in motion; you must have observed that your marble has always rolled much further on a smooth pavement than on a rough gravel walk."

"Certainly," said Tom; "and I well remember, that when we played at *ring-taw*, last winter, on the ice, we were obliged, for this very reason, to extend the usual boundaries."

"Exactly so; and your marble, under such circumstances, would run along like the enchanted bowl of the Dervise, in the Arabian Nights. Is it not evident, then, that the motion of a body is stopped by some opposing force; and that, if this could be entirely removed, the body would continue to move forever?"

"What a provoking thing this friction is!" said Tom; "it is always interfering with our experiments."

"Provoking, is it? I fancy," said Mr. Seymour, "that you would be much more provoked by the loss of it; without it you could not walk, nor even hold an object in your hands; and yet every thing around you would be in perpetual motion, performing one universal and interminable dance."

"I can readily understand, from what you have said, that, if friction were removed, motion might continue; but pray how is it that we should be unable to walk, or to hold any thing in our hands?" inquired Louisa.

"It is the friction of the ground which, at every step we take, prevents the foot from sliding back, and thus enables us to push the body forward. Everybody must have felt how difficult it is to walk on ice, where the friction is only diminished, not entirely removed," answered her father; "and as to holding any object," continued he, "it is the friction of the body to which we apply our hands that enables us to hold it firmly."

"To be sure," exclaimed the vicar; "why, my boy, you must surely remember, that in ancient combats it was the

custom to rub the body with oil, that the adversary might not be able to keep his grasp."

"Well," said Tom, "our houses, I suppose, would remain firm, and we might sit quietly in our chairs, at all events."

"Not so," replied Mr. Seymour; "for even granting that you had houses and chairs, which, without the existence of friction would never exist, the stability of the structures could never be secured; the slightest breath would be sufficient to make the stones or bricks slide off from each other, and to reduce your dwellings into dancing ruins."

Tom and Louisa, after some further discussion, both admitted the justness of the argument; but, at the same time, would have been better satisfied if the fact could have been proved by actual experiment. Mr. Seymour told them that the perpetual revolution of the earth and heavenly bodies, where no friction whatever existed, afforded a proof which ought to satisfy them; and, especially, since it agreed with those views which were proved to be true by an examination of what took place on the surface of our own globe.

We will, therefore, with the permission of our readers, consider this point as settled, and proceed with the young philosophers to the investigation of some other topics connected with the doctrine of motion.

"Since a body at rest," said Mr. Seymour, "can only be set in motion, or, when in motion, be brought to rest, by the impression of some force, it must follow that it can only move in the direction in which such a force may act; and, moreover, that the degree of motion, or the *velocity*, must, other things being equal, be in proportion to the degree of force used."

"Why, truly," cried the vicar, "my young friends must of necessity admit that fact; for the body, not having any will of its own, as you say, must needs, if it move at all, go the road it is driven."

"Yes," added Mr. Seymour, "and it must go with a velocity in proportion to the force with which it is driven."

"Doubtless, doubtless," cried the vicar, "you admit that also; do you not, my young friends and playmates?"

It is hardly necessary to state that the children instantly assented to these propositions. The vicar had placed them in so clear and popular a point of view, as to be intelligible to the lowest capacities.

"With these admissions, then, my dear children, said their father, "I shall have but little difficulty in convincing you of the truth of the other laws by which the direction of moving bodies is governed. At present, however, it is not my intention to enter upon this subject: you have some preliminary knowledge to acquire before you can understand what is termed the *Composition and Resolution of Forces*."

"I shall not easily forget," said Louisa, "that matter is perfectly passive, and that it can neither put itself in motion when at rest, nor stop itself when in motion."

"This indifference to rest or motion," replied Mr. Seymour, "has been termed the *Vis Inertia* of matter."

"A very objectionable term—a very puzzling expression," exclaimed the vicar, "to denote a mere state of passive indifference by the word *Vis*, or power, does appear to me, who have been in the habit of connecting words with ideas, as excessively absurd."

"I allow," said Mr. Seymour, "that the simple word *Inertia* would have been preferable; but we are bound to receive an expression which has been long current. I suppose, however, you know that the addition of *Vis* originated with Kepler, who, like my boy Tom, could not help thinking that the disposition of a body either to maintain or resist motion indicated something very like power; but we will not waste our time upon verbal disquisitions, although I cannot part with you, my dear vicar, without reminding you that there is ample classical authority for this apparent contradiction of terms. The connecting two ideas, which at first sight appear opposed to each other, constituted a figure of speech much used both by the Greeks and Romans."

"Unquestionably," said the vicar: "Euripides delighted in

it, and that was a sufficient reason for Aristophanes to satirize it. Horace, too, has given us several examples of it, as '*Insaniens Sapientia*,' '*Strenua Inertia*,' and in our own times we hear of lawyers talking of '*Long Briefs*!'

"It is clear," continued Mr. Seymour, "that matter, at rest, resists being put in motion; the degree of that resistance is always in proportion to the degree of force applied to put it in motion; or, to speak more philosophically, that *Action and Reaction are equal, and in opposite directions*."

"You surely do not mean to say," exclaimed Tom, "that if I strike my marble, the marble strikes my hand with the same force in return?"

"Precisely; that is my meaning."

"What!" cried Louisa, "if a man strikes another on the face with his hand, do you seriously maintain that both parties suffer the same pain?"

"Oh, no, no," said Tom, "papa can never intend to say that; I am quite sure, if it were the case, Mr. Pearson would not be so fond of boxing our ears."

Mr. Seymour answered this question, by observing that, if the hand possessed the same degree of feeling as the face, they would both suffer equally under the conflict. "If," continued he, "you strike a glass bottle with an iron hammer, the blow will be received by the hammer and the glass; and it is quite immaterial whether the hammer be moved against the bottle at rest, or the bottle be moved against the hammer at rest, yet the bottle will be broken, though the hammer be not injured; because the same blow which is sufficient to shiver the glass is not sufficient to break or injure the lump of iron. In like manner, the blow that is sufficient to pain your sensitive face, and make your ears tingle, will not occasion the least annoyance to the obtuse hand of your preceptor. The operation of this law," continued Mr. Seymour, "will be exemplified in every step of our progress. When the marble, as it rolls along, strikes any obstacles, it receives, in return, a corresponding blow, which will be found to influence its subsequent direction. The peg of the top, as it rubs on the

ground, is as much influenced by the friction, as if a force were actually applied to it when in a state of rest; and when we consider the forces by which the kite is made to ascend into the air, you will learn, from the same law, the nature of that advantage which you derive from running with it."

The vicar observed that the subject of *Momentum* might be introduced, and advantageously explained, upon this occasion.

"Momentum," said Tom; "and pray what is that?"

"It is a power," replied his father, "intimately connected with motion; and, therefore, as your friend, the vicar, justly remarks, may be very properly introduced before we quit that subject. It is the force with which a body in motion strikes against another body."

"That," observed Tom, "must of course depend upon the velocity of the body's motion."

"Undoubtedly, my dear; the quicker a body moves, the greater must be the force with which it would strike against another body; but we also know that the heavier a body is, the greater also will be its force; so that *momentum*, you perceive, must have a relation to both these circumstances, viz., velocity and weight; or, to speak more correctly, *the momentum of a body is composed of its quantity of matter multiplied by its quantity of motion*: for example, if the weight of a body be represented by the number 8, and its velocity also by 8, its *momentum* will be represented by  $8 \times 8 = 9$ ; so that, in producing momentum, increased velocity will always compensate for deficiency of matter, and a light body may thus be made a more effective force than a heavy one, provided that its velocity be proportionally increased; thus, a small ball, weighing only *two pounds*, and moving at the rate of *five hundred feet* in a second, will produce as much effect as a cannon-ball of *ten pounds* in weight, provided it moved only at the rate of *one hundred feet* in the same time."

"Let me see," cried Tom, "whether I understand your statement. We must multiply, as you say, the weight by the velocity; the weight of the small ball you state at two

pounds, and it travels at the rate of five hundred feet in a second; then its momentum must be a thousand. The weight of the great ball is ten pounds, its velocity only a hundred feet, then its momentum must also be a thousand; because, in both cases, the sums multiplied into each other will give the same product."

"Exactly: and thus you perceive that the small ball becomes an exact balance to the larger one; the first making out in motion what it wanted in matter, while the latter makes out in matter what it wanted in motion. I wish you to keep this law of *Momentum* in your remembrance; upon it depends the action of all the *mechanical powers*, as they are termed; and which I shall hereafter more fully explain."

"I have heard," said Louisa, "that a feather might be made to produce as much havoc as a cannon-shot, if you could give it sufficient velocity."

"Unquestionably: but there is a practical difficulty in the attempt, from the resistance of the air, which increases, as you have already seen in the experiment of the paper and penny-piece (p. 46), as the weight of a body decreases: and which explains the adage, that '*Hercules cannot throw a feather further than a child.*' Were it not for this resistance of the air, a hailstone falling from the clouds would acquire such a momentum, from its accelerated velocity, as to descend like a bullet from a gun, and destroy every thing before it; even those genial showers which refresh us in the spring and summer months, would, without such a provision, destroy the herbage they are so well calculated to cherish. Had the elephant possessed the mobility of the beetle, it would have overturned mountains. From this view of the subject of *Momentum*," continued Mr. Seymour, "you will easily understand why the immense battering-rams, used by the ancients in the art of war, should have given place to cannon-balls of but a few pounds in weight. Suppose, for example, that the battering-ram of Vespasian weighed 100,000 pounds, and was moved, we will admit, with such a velocity, by strength of hands, as to pass through 20 feet in one second



of time, and that this was found sufficient to demolish the walls of Jerusalem, can you tell me with what velocity a 82-pounder must move to do the same execution?"

"I will try," said Tom, as he took out his pencil and pocket-book, to make the calculation.

"Stop, I think you will hardly succeed without my guidance," said his father; "let us therefore work it out together: now you will readily perceive that we must in the first place determine the *momentum* of the battering-ram, by multiplying its weight by its velocity, or in other words by the space which it passes over in a second of time."

"That I understand."

"Very well," continued Mr. Seymour, "its weight was 100,000 pounds, and its velocity such as to carry it through 20 feet in a second of time; now make the required calculation."

"I have done it—it is 200,000."

"You are quite right; now if this momentum, which must also be that of the cannon-ball, be divided by the weight of that ball, viz., 82 pounds, we shall obtain the velocity required, which is 62,500 feet."



## CHAPTER II.

THE CENTERS OF MAGNITUDE AND GRAVITY.—THE POINT OF SUSPENSION.—THE LINE OF DIRECTION.—THE STABILITY OF BODIES, AND UPON WHAT IT DEPENDS.—METHOD OF FINDING THE CENTER OF GRAVITY OF A BODY.—THE ART OF THE BALANCER EXPLAINED AND ILLUSTRATED.—WALKING ON STILTS.—VARIOUS BALANCING TOYS.

"In the first place," said Mr. Seymour, "can you tell me, Tom, what is meant by *the center of gravity*?"

"Its central point," answered the boy.

"Certainly not; the central point is termed its center of *magnitude*, not that of gravity; and it is only when a body is of uniform density and regular figure, that these centers of magnitude and gravity coincide, or fall in the same spot."

"I now remember that the center of gravity is that point about which all the parts of a body exactly balance each other."

"Have all bodies, whatever may be their shape, a center of gravity?" asked Louisa.

"Undoubtedly."

"And you say that every body will fall if this point is not supported?"

"Infallibly. And now, Tom," said Mr. Seymour, "can you tell me what is meant by the *line of direction*?"

The young philosopher was unable to answer this question, and his father therefore informed him, that if a perpendicular line were drawn from the center of gravity of a body to the center of the earth, such a line would be termed the *line of*

*direction*; along which every body, not supported, endeavors to fall; and he was also informed that, if this said line fell within the base of a body, such a body was sure to stand; but never otherwise.

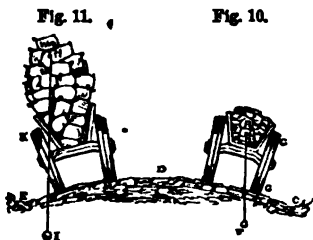
Louisa observed that she was not quite sure she understood her papa's meaning, and therefore begged for further explanation.

"I will exemplify it then," replied Mr. Seymour, "by a drawing. Fig. 10 represents a load of stones in a cart moving upon the sloping road *o d e*: this load being low down in the cart, *b* will represent its center of gravity, and *b r* its line of direction, which, you perceive, falls much within the supporting or lower wheel *g*: and there cannot, therefore be any danger of such a cart being overturned;

but in fig. 11 the center of gravity is raised from its former position to *h*, and *h i* is now the line of direction; which, falling without the base, or wheel *k*, the load will not be supported, and must consequently fall. These figures," added Mr. Seymour, "will also explain a fact which you must have frequently observed, that a body is stable or firm in proportion to the breadth of its base; hence the difficulty of sustaining a tall body, like a walking-stick, upon its narrow base; or that of balancing a hoop upon its edge, or a top upon its point; while, on the contrary, it is almost impossible to upset the cone or the pyramid, since in the latter cases, the *line of direction* falls within the middle of the base, the center of gravity of the body being necessarily low."

"I suppose," observed Louisa, "that this is the reason why carriages, when too much loaded, are so apt to upset."

"Say, when too much loaded on their *tops*, and you will be right. As you now, I trust, understand this part of the



subject, let us proceed a step further: if you take any body, with a view to suspend it, is it not evident that if it be suspended by that point in which the center of gravity is situated, it must remain at rest in *any* position indifferently?"

"I thought," said Tom, "we had already settled that question."

"True, my dear boy; but there is another question of great importance arising out of it, and which you have not yet considered: tell me, should the body be suspended on any other point, in what position it can rest?"

"I do not exactly understand the question."

"There are," replied his father, "only two positions in which it could rest, either where the center of gravity is exactly *above*, or exactly *below*, the point of suspension; so that, in short, this point shall be in the *line of direction*. Where the point of suspension is *below* the center of gravity, it is extremely difficult to balance or support a tall body by such a method, because the center of gravity is always endeavoring to get under the point of support. Look at this diagram, and you will readily comprehend my meaning.  $\kappa$  is the center of gravity of the diamond-shaped figure, which may be supported, or balanced, on a pin passing through it at  $m$ , as long as the center of gravity  $\kappa$  is immediately over the point of suspension  $m$ ; but if that center is removed in the slightest degree, either to the right or left of its place  $\kappa$ , the body will no longer retain its erect position  $\kappa m$ , but it will revolve upon  $m$ , and place itself in the situation indicated by the dotted lines beneath the point  $m$ , and its center of gravity will now be removed to  $n$ , directly *under*  $m$ , and in the line  $\kappa l$ , which, as you well know, is the line of direction. Have I rendered myself intelligible?"

"I understand it perfectly," answered Tom.

"And do you also, my dear Louisa?"

Louisa's answer was equally satisfactory, and



Mr. Seymour went on to state that the information they had now acquired would enable them to ascertain the situation of the center of gravity of any plane surface which was portable, notwithstanding it might possess the utmost irregularity of shape.

"You shall, for example," continued he, "find the center of gravity in your kite."

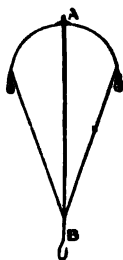
"I cannot say," observed Tom, "how I should set about it."

"Well, fetch your kite and I will explain the method."

Tom soon produced it, and the tail having been removed, Mr. Seymour proceeded as follows:

"I now," said he, "suspend the kite by the loop at its bow, and since it is at rest, we know that the center of gravity must be exactly below the point of suspension; if, therefore, we draw a perpendicular line from that point, which may be easily done by a plumb-line, with a weight attached to it, such a line will represent the *line of direction* (as indicated by *A B* in fig. 13)."

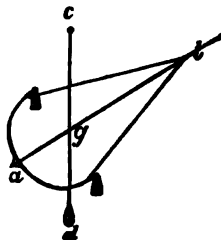
Fig. 13.



"It is clear enough," said Tom, "that the center of gravity must lie in the line *a b*, but how are we to find in what part of it?"

"By suspending the kite in another direction," answered Mr. Seymour, who then hung it up in the position represented at fig. 14, "and then by drawing another perpendicular from the new point of suspension."

Fig. 14.



"The center of gravity," said Louisa, "will in that case be in the line *c d*, as it was before in that of *a b*."

"In both the lines!" exclaimed Tom, with some surprise; "it cannot be in two places."

"And therefore," added Mr.

Seymour, "it must be in that point in which the lines meet and cross each other;" so saying, he marked the spot *g* with his pencil, and then told his little scholars that he would soon convince them of the accuracy of the principle. He accordingly placed the head of his stick upon the pencil mark, and the kite was found to balance itself with great exactness.

"True, papa," said Tom, "that point must be the center of gravity, for all the parts of the kite exactly balance each other about it."

"It is really," observed Louisa, "a very simple method of finding the center of gravity."

"It is," said Mr. Seymour; "but you must remember that it will only apply to a certain description of bodies: when they are not portable, and will not admit of this kind of examination, their centers of gravity can only be ascertained by experiment or calculation, in which the weight, density, and situation of the respective materials must be taken into the account. Having proceeded thus far, you have next to learn that the center of gravity is sometimes so situated as not to be *within* the body, but actually at some distance from it."

"Why, papa!" exclaimed Tom, "how can that possibly happen?"

"You shall hear. The center of gravity, as you have just said, is that point about which all the parts of a body balance each other; but it may so happen that there is a vacant space at this point. Where, for example, is the center of gravity of this ring? Must it not be in the space which the ring encircles?"

"I think it must," said Tom; "and yet how can it be ever supported without touching the ring?"

"That point cannot be supported," answered his father, "unless the ring be so held that the line of direction shall fall within the base of the support, which will be the case whether you poise the ring on the tip of your finger, or suspend it by a string, as represented in the figures which I

have copied from the 'Conversations on Natural Philosophy.' I need scarcely add, that it will be more stably supported in the latter position, because the center of gravity is below the point of suspension; whereas in the former the base is extremely narrow, and it will, consequently, require all the address of the balancer to prevent the center of gravity from falling beyond it. As you are now in possession of all the leading principles upon which the operations of the center of gravity depend, I shall put a few practical questions to you, in order that I may be satisfied you understand them. Tell me, therefore, why a person who is fearful of falling, as, for instance, when he leans forward, should invariably put forward one of his feet, as you did the other day, when you looked into Overton well?"



"To increase his base," answered Tom; "whenever I lean greatly forward, I should throw the line of direction beyond it, did I not at the same instant put out one of my feet, so as to extend my base, and thus to cause the line to continue within it."

"Rightly answered; and, for the same reason, a porter with a load on his back leans forward to prevent his burden from throwing the line of direction out of the base behind. So the horse, in drawing a heavy weight, instinctively leans forward, in order to throw the whole of his weight as a counterbalance; and yet," observed Mr. Seymour, "we are in the habit of ignorantly restraining him by a bearing-rein, in consequence of which he has to call in the aid of his muscles, by which a very unnecessary exhaustion of strength is produced. Thus is it that German and French horses draw heavy weights with apparently greater ease to themselves, because the Germans tie a horse's nose *downward*, while the French, more wisely, leave them at perfect liberty. But to proceed. Did you ever observe the manner in which a woman carries a pail of water?"

"To be sure," said Tom; "she always stretches out one of her arms."

"The weight of the pail," continued Mr. Seymour, "throws the center of gravity on one side, and the woman, therefore, stretches out the opposite arm, in order to bring it back again into its original situation; did she not do this, she must, like the English draught-horses, exert her muscles as a counter-acting force, which would greatly increase the fatigue of the operation: but a pail hanging on each arm is carried without difficulty, because they balance each other, and the center of gravity remains supported by the feet."

"I see," said Louisa, "that all you have said about the woman and her pail must be true; but how could she have learned the principle which thus enabled her to keep the center of gravity in its proper place?"

"By experience. It is very unlikely that she should ever have heard of such a principle, any more than those people who pack carts and wagons, and yet make up their loads with such accuracy as always to keep the line of direction in, or near the middle of the base. But to proceed to another example:—have I not frequently cautioned you against jumping up suddenly in a boat? Can you tell me upon what principle such an operation must be attended with danger?"

"I suppose," said Tom, "for the very same reason that a wagon is more likely to be overturned when its top is too heavily laden; it would elevate the center of gravity, and thereby render the line of direction liable to be thrown beyond the base, and so upset the boat."

Mr. Seymour observed, that after this lesson he thought the balancing which Tom and Louisa had witnessed at Astley's Theater last year, would cease to appear so miraculous. Louisa declared that she had now discovered the whole mystery.

"You have doubtless perceived," said her father, "that the art entirely consists in dexterously altering the center of gravity upon every new position of the body, so as constantly to preserve the line of direction within the base. Rope-



dancers effect this by means of a long pole, the ends of which are loaded by weights, and which they hold across the rope. If you had paid sufficient attention to their movements, you must have perceived how steadily they fixed their eyes on some object near the rope, so as to discover the slightest deviation of their center of gravity to one or the other of its sides, which they no sooner detect, than they instantly rectify it by a countervailing motion of their pole, and are thus enabled to preserve the line of direction within the narrow base. This very same expedient is frequently practiced by ourselves; if we slip or stumble with one foot, we naturally extend the opposite arm, making the same use of it as the rope-dancer does of his pole. Many birds, also, by means of their flexible necks, vary the position of their center of gravity in the same manner. When they sleep, they turn it toward the back, and place it under the wing, in order to lay the greatest weight on the point above the feet."

"What an interesting subject this is," cried Louisa, "and how many curious things it is capable of explaining!"

"Indeed is it; and I shall take an opportunity of pointing out several specimens of art which are indebted for their stability to the scientific application of the principle we have been considering;—but I have now a paradox for you, Tom."

"Let us hear it, papa."

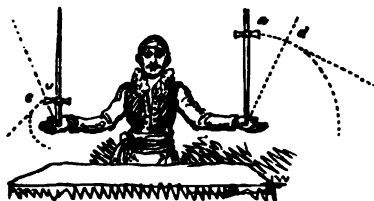
"How comes it that a stick, loaded with a weight at the upper extremity, can be kept in equilibrio, on the point of the finger, with much greater ease than when the weight is near the lower extremity; or, for instance, that a sword can be balanced on the finger much better when the hilt is uppermost?"

"That is indeed strange. I should have thought," replied Louisa, "that the higher the weight was placed above the point of support, the more readily would the line of direction have been thrown beyond the base."

"In that respect you are perfectly right; but the balancer will be able to restore it more easily in one case than in the other; since, for reasons which you will presently discover

the greater the circle which a body describes in falling, the less will be its tendency to fall. Look at the sketch which I have prepared for the explanation of this fact, and I think you will readily comprehend the reason of it.

"When the weight is at a considerable distance from the point of support, its center of gravity, in deviating either on one side or the other from a perpendicular direction, describes a larger circle, as at *a*, than when the weight is very near the center of rotation or the point of support, as at *b*. But, in a large circle, an arc of any determinate extent, such as an inch, for example, describes a curve which deviates much less from the perpendicular than if the circle were less; as may be seen by comparing the positions of the sword at *d* and *e*; and the sword at *d* will not have so great a tendency to deviate fur-



ther from the perpendicular, as that at *e*; for its tendency to deviate altogether from the perpendicular is greater, according as the tangent to that point of the arc, where it happens to be, approaches more to the vertical position. You see then that it is less difficult to balance a tall, than a shorter pole; and it is for the same reason that a person can walk with greater security on high than on low stilts."

"That is very clear," said Louisa, "although, before your explanation, I always associated the idea of difficulty with their height."

"I suppose," added Tom, "that the whole art of walking on stilts may be explained by the principles you have taught us."

"Undoubtedly it may for the equilibrium is preserved by

varying the position of the body, and thus keeping the center of gravity within the base."

"It must be a great exertion," observed Louisa.

"Before custom has rendered it familiar; after which, there is no more fatigue in walking on stilts than in walking on our feet. There is a district in the south of France, near Bourdeaux, called the Desert of Landes, which runs along the sea-coast between the mouths of the Adour and Gironde, where all the shepherds are mounted on stilts; on which they move with perfect freedom and astonishing rapidity; and so easily does habit enable them to preserve their balance, that they run, jump, stoop, and even dance, with ease and security."\*

"How very odd!" said Tom; "what can be their motive for such a strange habit?"

"Its objects," replied his father, "are important: to keep the feet out of the water, which, during the winter, is deep on the sands; and to defend them from the heated sand during the summer; in addition to which the sphere of vision over so perfect a flat is materially increased by the elevation, and the shepherds are thus enabled to see their flocks at a much greater distance.† They cannot, however, stand perfectly still upon their stilts, without the aid of a long staff, which they always carry in their hands; this guards them against any accidental trip, and when they wish to be at rest, forms a third leg that keeps them steady."

"I suppose," said Louisa, "that the habit of using these stilts is acquired while they are very young."

"It is, my dear: and it appears the smaller the boy is, the

\* Stilts also enjoyed for centuries very considerable celebrity in the city of Namur. The frequent inundations of the Meuse and Sambra, which formerly used to flood it, led, doubtless, in the first instance to their employment; but that which was originally a necessity, became in the course of time an amusement, and one that developed singular features. As far back as the eleventh century may be traced the existence of games on stilts, which gradually assumed a party character; and the players finally resolved themselves into distinct bodies, ready at all times to do battle against each other, even to the peril of life and limb.—*Costello's Tour through the Valley of the Meuse.*

† In Scotland stilts are used to pass rivers.

higher are his stilts; a fact which affords a practical proof of the truth of what I have just stated."

"The stork is said, in my work on Natural History, to be always walking on stilts," said Louisa; "and yet it does not appear to fatigue him."

"That is very true," replied the father; "but you must remember, that nature has furnished the bird with a provision, by which the legs are kept extended without any exertion of the muscles, in the manner of certain strings; a structure which enables it to pass whole days and nights on one foot, without the slightest fatigue. If you will visit the cook the next time she trusses a fowl, you will at once perceive the nature and utility of this structure; upon bending the legs and things up toward the body, you will observe that the claws close of their own accord; now, this is the position of the limbs in which the bird rests upon its perch, and in this position it sleeps in safety; for the claws do their office in keeping hold of the support, not by any voluntary exertion, but by the weight of the body drawing the strings tight."

"But, papa," said Tom, "I have yet some more questions to ask you on the subject of balancing. I am not at all satisfied about many of the tricks that we saw last year; indeed, I cannot believe that many of those astonishing feats can be explained by the rules you have just given us."

"I very well know to what you allude," replied Mr. Seymour. "Many singular deceptions are certainly practiced by removing the center of gravity from its natural into an artificial situation, or by disguising its place; thus, a cylinder placed upon an inclined surface may be made to run *up*, instead of *down* hill. I can even appear to balance a pailful of water on the slender stem of a tobacco-pipe; but I shall be enabled to explain the nature of these deceptions by some toys which I have provided for your amusement, and which I must say you are fully entitled to possess, as a reward for the clear and satisfactory manner in which you have this day answered my questions. But see! here comes Mr. Twaddleton: he would really seem to possess an instinct that always

brings him to the Lodge whenever I am preparing some amusement for you."

The vicar smiled as he entered the room, but, unwilling to interrupt the lesson, he placed his fore-finger on his lip, and, with a significant nod, silently took a seat at the table. The children laughed aloud at this cautious demeanor; and Tom exclaimed, "Why, Mr. Twaddleton, our lesson is over, and we are going to receive some new toys as a reward."

"I have here," said Mr. Seymour, as he opened a large wooden box, "a collection of figures, which will always raise themselves upright, and preserve the erect position; or regain it, whenever it may have been disturbed."

He then arranged these figures in battalion on the table, and striking them flat by drawing a rod over them, they immediately started up again, as soon as it was removed. "These figures," continued he, "were bought at Paris some years ago, under the title of *Prussians*."

"I declare," exclaimed the vicar, "they remind me of the rebellious spirits whom Milton represents as saying that ascent is their natural, and descent their unnatural, motion."\*

"I have seen screens similarly constructed," said Mrs. Seymour, "which always rose up of themselves, upon the removal of the force that had pressed them down."

"I will explain their principle," said Mr. Seymour.

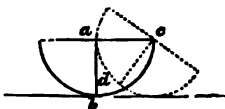
"Suppose we first examine the construction of the figure," observed the vicar. "Bless me! why it is like the poet Philotus of Cos, who was so thin and light, that lead was fastened to his shoes to prevent his being blown away."†

\* The vicar here alludes to the speech of Moloch (Parad. Lost, b. ii. l. 75):

"That in our proper motion we ascend  
Up to our native seat: descent and fall  
To us is adverse."

† This story is related by Ælian, who at the same time discredits it, for, says he, "how could he carry about a sufficient weight to prevent his being blown away, if he were so weak as not to be able to resist the sea breeze?" This matter-of-fact way of regarding a humorous fable is exceedingly amusing, and reminds the author of a somewhat similar criticism upon an American story which he had related. A traveler, after a long journey, anxiously

"The figure," said Mr. Seymour, "is made of the pith of the elder-tree, which is extremely light, and is affixed to the half of a leaden bullet; on account, therefore, of the disproportion between the weight of the figure and that of its base, we may exclude the consideration of the former, and confine our attention to the latter. The center of gravity of the hemispherical base is, of course, in its axis; and therefore tends to approach the horizontal plane as much as possible, and this can never be accomplished, until the axis becomes perpendicular to the horizon. Whenever the curved surface is in any other position, the center of gravity is not in the lowest place to which it can descend, as may be seen by the diagram which I have just sketched. If the axis  $ab$  be removed to  $cd$ , it is evident that the center of gravity will be raised, and that, if left alone, it would immediately descend again into its original position."

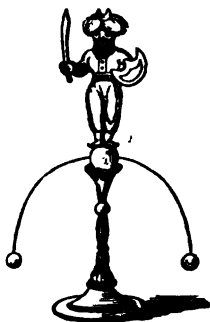


"I understand it perfectly," said Tom. "When the axis  $ab$  is perpendicular, the center of gravity will be in its lowest point, or as near the earth as it can place itself; when,

looked about for some inn wherein his jaded horse might have a bait; but all in vain, no such accommodation was to be found: his next attempt was to find a grassy spot that could afford some pasturage, but in this again he failed. In this dilemma his ingenuity suggested a resource, which proves, for the thousandth and first time, the truth of the old adage, that "Necessity is the mother of Invention;" drawing from his pocket a pair of green glass spectacles, he placed them upon the horse's face, and led him into a carpenter's yard, when the deluded animal immediately commenced his meal upon the shavings of wood and sawdust. The absurdity of this story necessarily excited a general laugh, but with one exception: it was evident that one of the company did not sympathize with his companions, and after a few minutes of apparent abstraction, he exclaimed, with an air of much solemnity, "I must beg your pardon, sir; but I entertain strong doubts as to the truth of your story, for I cannot understand how the spectacles could have been fixed on the horse's nose." So true is the saying, that "*the prosperity of a just lies in the ear of him who hears it.*"

therefore, the figure is pressed down, the center of gravity is raised, and, consequently, on the removal of that pressure, it will descend to its original position, and thus raise the figure."

"I see you understand it. Here, then," continued Mr. Seymour, "is another toy in further illustration of our subject. It consists of a small figure, supported on a stand by a ball, which is quite loose; and yet it is made to turn and balance itself in all directions, always recovering its erect position, when the force applied to it is removed. The two weights, in this case, bring the center of gravity considerably *below* the point of suspension or support, and therefore maintain the figure upright, and make it resume its perpendicular position, after it has been inclined to either side; for the center of gravity cannot place itself as low as possible, without making the figure stand erect."



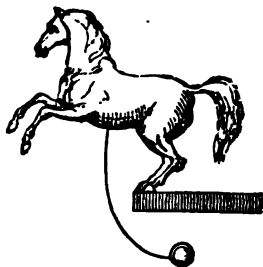
"That is very evident," cried Louisa.

"I shall next exhibit to you," continued Mr. Seymour, "a toy that furnishes a very good solution of a popular paradox in mechanics; viz., *A body having a tendency to fall by its own weight, how to prevent it from falling, by adding to it a weight on the same side on which it tends to fall.*"

"That is indeed a paradox!" exclaimed Louisa. "The next time I see the gardener sinking under the load of a heavy sack, I shall desire him to lighten his burden by doubling its weight."

"Will you, indeed, Miss Pert? I do not think so, after you have seen the operation of the toy I am now about to exhibit. Here, you perceive, is a horse, the center of gravity of which would be somewhere about the middle of its body; it is, therefore, very evident that, if I were to place its hinder legs

on the edge of the table, the line of *direction* would fall considerably beyond the base, and the horse must be precipitated to the ground; you will, however, perceive that there is a stiff wire attached to a weight which is connected with the body of the horse, and by means of such an addition, the horse prances with perfect security at the edge of the precipice; so that the figure which was incapable of supporting itself is actually prevented from falling, by adding a weight to its unsupported end!"



The children admitted the truth of this statement, and were not immediately prepared to explain it.

"The weight, indeed, appears to be added on that side; but, in reality, it is on the opposite side," said the vicar.

"In order to produce the desired effect," observed Mr. Seymour, "the wire must be bent, so as to throw the weight far back, under the table; by which contrivance, since the center of gravity of the whole compound figure is thrown into the leaden weight, the hind legs of the horse thus become the point of suspension, on which the ball may be made to vibrate with perfect security."

"Now I understand it," cried Tom; "instead of the weight supporting the horse, the horse supports the weight."

"Exactly so. You perceive, therefore, from these few examples, that the balancer, by availing himself of such deceptions, and combining with them a considerable degree of manual dexterity, may perform feats, which, at first sight, will appear in direct opposition to the laws of gravity. There is also another expedient of which the balancer avails himself, to increase the wonder of his performances, and that is the influence of rotatory motion, which, you will presently see, may be made to counteract the force of gravity."

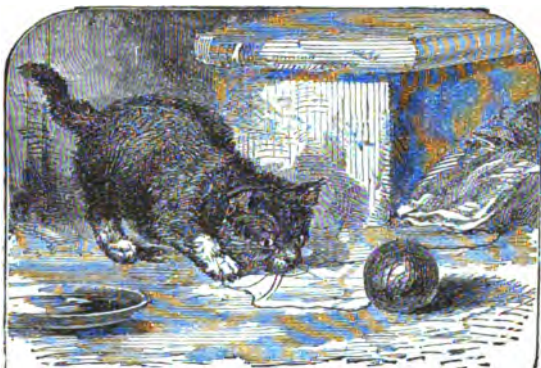
"I remember that the most surprising of all the tricks I



witnessed was one, in which a sword was suspended on a key, which turned round on the end of a tobacco-pipe; on the top of the sword a pewter-plate was, at the same time, made to revolve with great velocity."

"I well remember the trick to which you allude. The rotatory motion prevented the sword from falling, just as you will hereafter find the spinning of the top will preserve it in an erect position. There is also another effect produced by rotatory motion, with which it is essential that you should become acquainted. You no doubt remember that momentum, or the velocity of a body, will compensate for its want of matter. A number of bodies, therefore, although incapable of balancing each other when in a state of rest, may be made to do so, by imparting to them different degrees of motion. I believe that you are now acquainted with all the principles upon which the art of balancing depends; and I have little doubt, should we again witness a performance of this kind, that you will be able to explain the tricks which formerly appeared to you so miraculous."





## CHAPTER III.

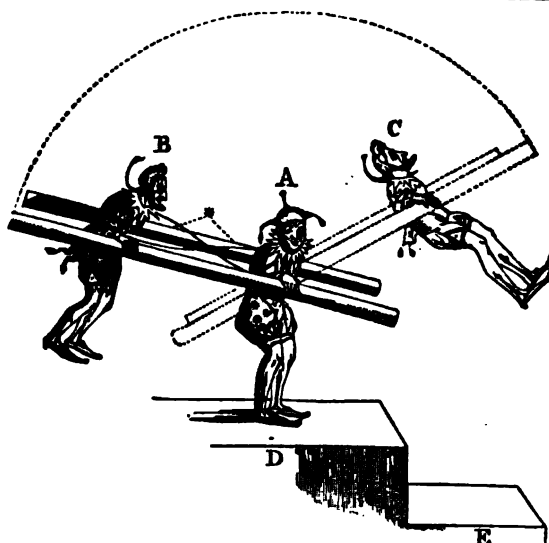
"I TRUST," said Mr. Seymour, "that after our late discussion, the subject of the center of gravity is thoroughly understood by you all. I have also reason to think that the nature and effects of what is termed *momentum* have been rendered intelligible to you."

"I certainly understand both those subjects," answered Tom; and so thought the rest of the party.

"Well, then, I will put your knowledge to the test," observed Mr. Seymour, "for you shall explain to me the mechanism of these *Chinese Tumblers*."

Mr. Seymour then proceeded to point out the mechanism and movements of the toy in a manner which we shall endeavor to convey to our readers by the aid of the annexed engraving.

"As soon as the figure A is placed upon the step D, in the position A B, the quicksilver, by running down the inclined tubes, swings the figure B round to C; and the center of gravity having been thus adjusted, the whole would remain at rest but for the contrivance to be next described. Besides their connection with the poles by means of pivots, the figures are connected with each other by silken strings, which keep the figure B steadily in its position, while it traverses



the arc until it arrives at C, when their increased tension has the effect of capsizing it, and of thus producing a momentum, which, by carrying its center of gravity beyond the line of direction, causes it to descend upon the step E, when the quicksilver, by again flowing to the lowest part of the tubes, places the figures in the same position, only one step lower, as they were at the commencement of their action; and thus, by successive repetitions of the same changes, it is quite evident that the figures must continue to descend as long as any steps remain for their reception."

"I understand it perfectly," observed Louisa, with a smile of satisfaction.

"I need scarcely say," continued Mr. Seymour, "that there are some niceties in the adjustment of the minor parts of the apparatus, without which the effect could not be accomplished; the quantity of quicksilver, for instance, must bear

its proper proportion to the weight and dimensions of the figure; and in order to prevent its too rapid passage along the inclined tubes, strings are stretched across their interior to retard the stream. Then, again, some management is necessary with regard to the silken strings, in order to insure a necessary degree of tension. I will now show you," said he, "a single tumbler, which will perform the same motions without the assistance of any tubes."

"But not without quicksilver," observed Tom, "which, I suppose, must, in this case, be put into the body of the figure."

"You are quite right; and it is made to pass from one extremity of its body to the other through a small orifice, which has the same effect as the strings in the tubes, in breaking the current and preventing its too rapid motion. In all other respects, the principle is the same as in the double figures."

Just as Mr. Seymour had terminated his exhibition of "*Le petit Culbuteur*," the welcome appearance of the vicar infused fresh spirits into the little party.

"My dear friends," said Mr. Twaddleton, "I have been most provokingly detained by that tiresome etymologist, Jeffrey Prybabel. I made many efforts to escape, but I was as a fly in a cobweb."

"At all events, I am glad to find that you have not been strangled by *Mutes*. I knew Prybabel well," observed Mr. Seymour, "when he practiced as a Conveyancer in Gray's Inn, and went by the nickname of the *Riot Act*; for, in such horror was he held, that, if a number of persons were congregated, his approach was sure to disperse them. But what has been the subject of your discourse?—was the etymologist merely airing his vocabulary, or did he propose some difficult question for discussion? Be this, however, as it may, I will venture to say that he was, as usual, loquacious on the subject of *mutes*—dry on the use of *liquids*, and desecanting without end on the importance of a *termination*."

"Mr. Seymour, I am really and truly ashamed of you;

punning under any circumstances is a most vexatious habit, but when employed to distort the meaning of language it becomes absolutely criminal."

To turn the subject of this discourse, the vicar proceeded to inform Mr. Seymour that he had no sooner escaped from the fangs of Prybabel than he encountered *Polyphemus*. Our readers may, perhaps, wonder who this *Polyphemus* could have been; we must, therefore, inform them that Mr. Twaddleton, whose ideas were always tinctured with classical coloring, had bestowed this appellation upon the renowned Dr. Doseall, the Esculapius of Overton, because, as he said, his practice was like the Cyclops, *strong but blind*; and Mr. Seymour declared that the similitude was even more perfect than the vicar had contemplated, for he observed that he certainly fattened upon the unhappy victims who fell within his clutches.

With all our respect for the liberality of Mr. Seymour and the kind-heartedness of the vicar, we must, in justice to this respectable son of Apollo, express our disapprobation at so unprovoked a sarcasm. We acknowledge that Dr. Doseall, by the aid of low bows and high charges—of little ailments and large potions, had contrived to secure a very comfortable balance on the creditor side of his worldly ledger. We also admit, that after the example of other celebrated practitioners, he had one sovereign remedy, which he administered in every disease. But what of that? he was often successful in his cures—that is to say, his patients sometimes recovered *after* they had taken his physic; and is not that the test conventionally received in proof of the skill or ignorance of greater physicians than Dr. Doseall? Nor can we persuade ourselves into the belief, that a doctor who faithfully adheres to one single remedy, is less likely to be right than those restless spirits who are eternally coquetting with all the preparations of the Pharmacopœia without ever remaining steady to any one of them. It has been truly remarked that the clock which stands still and points steadfastly in one direction, is certain of being right twice in the twenty-four hours,

while others may keep going continually, and as continually going wrong. Being ourselves no doctors, we merely throw out this hint for the consideration of those who are learned in such matters; but we beg pardon of our readers for this digression.

"Well," said Mr. Seymour, "I am, at all events, rejoiced to see our Trojan in safety, after such perilous adventures; and I hope that he is now prepared to set sail again with us, on a new voyage of discovery. I have been engaged," continued he, "in explaining still further the nature of momentum, and I now propose to exhibit an experiment of a different kind, in order to illustrate the same subject. You, no doubt, remember," continued Mr. Seymour, "that velocity makes up for weight; and therefore, although a fluid, as air, or water, may, in a state of quiescence, be unable to support a body, yet, by giving it a certain velocity, it may acquire a sustaining power. I have here several gilded pith-balls, through one of which I have run two pins, at right angles to each other: the naked points, you perceive, are defended with sealing-wax, to prevent any mischief that might arise from their accidentally coming into contact with your face. By means of this brass tube (the stem of a tobacco-pipe will answer the same purpose), I shall produce a current of air by my breath, and you will observe that the little ball will continue to dance, as if unsupported."

Mr. Seymour then placed the pith-ball at the end of the pipe, and, inserting its other extremity in his mouth, blew out the ball, which immediately rose in the air, and continued to float about for several seconds: he then drew in his breath, and caught it with much address on one of its points; and in this manner, alternately floating and catching it, did he continue to delight the wondering group for several minutes.

Tom received the tube and ball from the hand of his father, and soon succeeded in playing with it. Observe, gentle reader, the address with which the boy manages it.

"This reminds me of my pea-shooter," said Tom, as he

removed the tube from his mouth, "with which I have often shot a pea across the play-ground."

"Exactly; and you will now understand the nature of the force by which your pea was projected. The air blown from the lungs gains such momentum from the contracted channel in which it flows, as to impart considerable velocity to the pea placed within the influence of its current."



Mrs. Seymour observed that she had lately read in Waterton's "Wanderings in South America" a very interesting account of the Indian blow-pipe, which the natives of Guiana employ as an engine for projecting their poisoned arrows, and which owes its power to the principle of which Mr. Seymour had just spoken, and its unerring accuracy to the skillful address of the Indian who uses it.

"Mr. Seymour," said the vicar, "I much like your experiment with the pith-balls; but do tell me the use of the pins that are passed through them."

"They are not absolutely necessary for the success of the experiment; indeed, I ought to have stated that their only use is to insure the elevation of the ball to a certain distance above the orifice of the tube, before it is set adrift."

"*'Ne turbata volent rapidis ludibria ventis,'* as Virgil has it. I duly appreciate the contrivance; but if the ball was set off at a distance from the orifice, such an expedient would be unnecessary."

"Certainly," answered Mr. Seymour; "I will soon convince you that, under the condition you propose, the pins are not essential."

So saying, he placed the tube in his mouth, and by carefully holding the ball at a distance of about half an inch from its orifice, he was enabled to consign it at once to a continuous and steady stream of air, which can never be commanded at the point from which the air issues; and he thus succeeded

in sustaining the ball in motion, in the same manner as he did in the preceding experiment."

"We will now proceed to the orchard," said Mr. Seymour, "where I have prepared another pleasing exhibition of a similar description."

The party accordingly left the Lodge, and when they had arrived at the fountain, their father produced a small wooden figure, of which the annexed is a sketch. Within its base was fixed a hollow sphere, or ball of thin copper, which when properly adjusted on a fountain, or *jet d'eau*, was sustained by the momentum produced by the velocity of the stream; so that the whole figure was balanced, and made to dance on the fountain, as the pith-ball had been made to play in the current of air.

The children were much gratified at witnessing so curious an exhibition. Mr. Twadleton laughed heartily at the ludicrous effect it produced, and observed that, although he had never before seen the experiment, he had frequently heard of it; and he added, that he understood it to be a very common toy in Germany and Holland.

"I have for some time," said Mrs. Seymour, "been trying to construct a light figure of this kind, which shall dance on a current of air; and I believe I have at length succeeded. The head I have formed of the seed-vessel of the *Antirrhinum*, which has a striking resemblance to a face, and possesses, moreover, the indispensable condition of lightness. The dress is made of silver paper, stretched over a cone of the same material. From its appearance I have named it the *Flying Witch*."

"I admire your ingenuity," said Mr. Seymour, "and I have no reason to doubt the success of your enterprise."

"I found it convenient," continued Mrs. Seymour, "to place a stage of card below the orifice of the tube, in order to





steady the figure as she rises, and to receive her as she falls."

"Your principal care," observed her husband, "must be to throw the center of gravity of the figure as low as possible, and which you may readily accomplish by shot suspended by silken strings from the base of the figure."

On the party returning to the library, Mr. Seymour expressed a wish that, before they suspended their morning's recreations, they should take into consideration a peculiar property of matter, which they had not yet discussed.

"And what may that be?" asked Louisa.

"ELASTICITY," replied her father; "and I wish to hear whether Tom can explain to us the meaning of the term."

Tom very well knew what was meant by Elasticity; but he was like many a merchant with a bill of exchange, who, although well acquainted with its value, has not sufficient small change to cash it. Tom wanted words to enable him to furnish a clear definition; his father, therefore, kindly relieved his embarrassment, by informing him that "it was a property inherent in certain bodies, by which they possessed a disposition to have their form altered by force or pressure, and to recover it on the removal of that pressure, throwing off the striking body with some degree of force: for example," continued he, "the cane which I hold in my hand can be bent to a certain extent, and then, if I let it go, it will immediately return to its former condition with considerable force."

Louisa inquired whether bending and pressing upon a body were the same thing. Mr. Seymour replied, that the form of an elastic body might be altered either by compression or distension, and that *bending* was, in fact, only a combination of these two methods; "for," said he, "when a straight body, like my cane, is bent, those particles of it which are on the one side are compressed, while those on the other are distended. But let us proceed with the subject. I have said that elastic bodies, on returning to their original form, throw off the striking body with some degree of force. I have

here," continued Mr. Seymour, taking out of his pocket a wooden image of a cat, "a toy which I intend as a gift to John; it will serve to illustrate our subject. The tail, you perceive, is movable, one of its ends being tied to a piece of catgut, which is a highly elastic substance. When I bend the tail under the body of the animal, I necessarily twist the string; and by pressing the other end of the wooden tail upon a piece of wax, I can retain it for a few seconds in that situation."

Mr. Seymour, having fixed the tail in the manner above described, placed the wooden image on the ground, when, in a few seconds, it suddenly sprang forward, to the great delight of the younger children.

"Can you explain this action?" asked Mr. Seymour.

"The wax," answered Tom, "was incapable of holding the end of the tail longer than a few seconds; and as soon as it was let loose, the elasticity of the catgut enabled it to return to its former condition; in doing which the tail struck with force against the ground, which threw off the body of the cat and produced the leap."

"Very well explained; and you, no doubt, will readily perceive that the operation of steel springs depends upon the same principle of elasticity: a piece of wire or steel, coiled up, may be made to set a machine in motion by the endeavor it makes to unbend itself. This is the principle of the spring in a watch. When our watches are what is termed *down*, this steel has uncoiled itself; and the operation of winding them up, is nothing more than that of bending it again for action. If the elasticity of a body be *perfect*," added Mr. Seymour, "it will restore itself with a force equal to that with which it was compressed. As I have given John a toy, it is but fair that I should reward you, Tom: open that box, and examine the gift which it contains."

Tom received the present from his father, and proceeded to open the lid, when, to his great astonishment, the figure of an old witch suddenly sprang upward. Mr. Seymour explained its mechanism, by stating "that the figure contained a wire

coiled up like a cork-screw, and which, upon the removal of the pressure of the lid which confined it, immediately regained its original form."

Tom inquired what kind of bodies was most elastic. He was informed that the air was the most elastic of all known substances, and had, for that reason, been distinguished by the name of an *elastic* fluid. Hard bodies were so in the next degree; while soft substances which easily retain impressions, such as clay, wax, &c., might be considered as possessing but little elasticity.

"I should have thought," said Louisa, "that neither clay nor wax had possessed *any* elasticity."

"My love, we know not any bodies that are absolutely, or perfectly, either hard, soft, or elastic; since all partake of these properties, more or less, in some intermediate degree. Liquids are certainly the least elastic of all bodies; and, until lately, water was regarded as being perfectly inelastic;\* but recent experiments have shown it capable of compression, and of restoring itself to its original bulk, as soon as the pressure is removed; it must, therefore, possess some elasticity. Indeed," said Mr. Seymour, "we might have anticipated such a result from the effects which present themselves in the well-known game of '*Ricochet*,' or *Duck and Drake*."

"*Duck and Drake*!" exclaimed Louisa; "for goodness' sake, what can that game be?"

"I dare say your brother will not have any difficulty in explaining it to you."

Tom informed her that it was a game of *water-skimming*, in which any number of boys threw a stone, an oyster-shell, or a flat piece of tile, into the water; and that he whose stone rebounded the greatest number of times was the conqueror.

"It is a very ancient game," said Mr. Seymour, "and had the vicar been present, we should have heard a learned disquisition upon it; as he, however, is unfortunately absent, I

\* The comparative inelasticity of water will be shown hereafter.





must tell you all I know upon the subject. It was called by the Greeks *Epostrakismos*,\* and was anciently played with flat shells. Now it is evident that the water must, under certain conditions, possess some degree of elasticity, or the stone could not rebound; but I shall have occasion to revert to the subject hereafter."

"And are my marbles elastic?" asked Tom.

"Undoubtedly; but not to the same extent as your ball. There," said Mr. Seymour, throwing his ball against the wall, "see how it rebounds."

"The return of the ball," observed Tom, "was, I suppose, owing to its elasticity; and I now understand why one filled with air rebounds so much better than one stuffed with bran or wool."

"You are quite right; and the return of the ball, after having struck the wall, affords an example of what is termed *reflected* motion, upon which I shall have to remark when we come to the interesting subject of 'Compound Forces;' but at present, my only wish is to render the property of elasticity intelligible to you. It is a force of very extensive application; there is scarcely a machine wherein the elasticity of one or more solids is not essentially concerned. Nature, also, avails herself of this property to accomplish many of her purposes. Fleas and locusts are enabled to jump two hundred times the height of their own bodies by means of a springy membrane, easily visible by a microscope; so that, supposing the same relative force to be infused into the body of a man six feet high, he would be enabled to leap three times the height of St. Paul's. The hinder legs of the flea are also much longer than the fore ones; when about to leap it bends them toward the body, and then, by suddenly extending them, effects the leap. The '*Industrious Fleas*,' lately exhibited in London, were deprived of this power by having the hinder legs amputated at the knee-joint."

"I suppose," said Tom, "that it is by some such spring

\* Pollux, lib. ix. c. 7; also in Minucius Felix, Lugd. Bat. 1602, p. 2.

shrimps are enabled to leap to the tops of cataracts, as I have read in my work on Natural History."

"Many species of fish are thus enabled to leap, by bending their bodies strongly, and then suddenly unbending them with an elastic spring; and the long-tailed cray-fish, and the common shrimp, leap by extending their tails, after they have been bent under their bodies:—but the most striking example of this kind is the leap of the salmon; just under the cataract, and against the stream, he will rush for some yards, and rise perpendicularly out of the spray twelve or fourteen feet; and, amidst the noise of the water, he may be heard striking against the rock with a sound like the clapping of hands; if he find a temporary lodgment on the shelving rock, he will lie quivering and preparing for another summer-set, until he reaches the top of the cataract; thus at once exhibiting the elasticity of his bones and the power of his muscles."

"Nature also avails herself of this property for accomplishing many purposes in the vegetable kingdom; the regular dispersion and sowing of the seeds of several plants is effected by a spring, which is wound sometimes round the outside, and sometimes round the inside of the case in which the seeds are contained."

"We will now conclude our diversions," said Mr. Seymour, with an exhibition of a very striking description. Here," cried he, as he removed a small piece of apparatus from a box which stood on the table, "is a toy, at which the sternest philosopher, nay, even Heraclitus, of weeping memory, could not refrain from laughing."

He then displayed a small ball of india-rubber, on which was painted an exact resemblance of the worthy vicar, executed under the direction of Mr. Seymour, by that inimitable artist, George Cruikshank. The ball was connected with an air-syringe, by which it was easily distended. It gradually increased in magnitude, swelling, like the gourd of Jonah, as the inflation proceeded, and the countenance of the vicar progressively enlarged to the size of the full moon, without

the least alteration in the character or expression of his features.

"I declare," said Mr. Seymour, "the vicar *improves upon acquaintance*."

"It must be acknowledged that you have *puffed* him into consequence," observed Mrs. Seymour.

The countenance had, after a short time, swelled to ten times its original dimensions: the children deafened Mr. Seymour with their shouts, and the good-humored clergyman was actually convulsed with laughter. The stop-cock was now turned; the elastic bladder became smaller and smaller, and the features underwent a corresponding diminution, until they once again assumed their original dimensions.

"You perceive, my dear sir, that I make you *look small* again."

"That is by no means an unusual effect of your jokes," replied the vicar.

"Now, Tom," said his father, "it is for you to explain the nature of the exhibition you have just witnessed."

Tom proceeded accordingly.

"The bladder was highly elastic, and therefore readily yielded to the pressure of the air, and became distended. As soon, however, as the pressure was removed, the air was driven out again with force, and the particles of indian-rubber returned to their former condition. But I observed one circumstance which I do not understand," said Tom: "when you first turned the stop-cock, the air rushed out with great violence, and the ball diminished very rapidly; but it gradually slackened, until, at last, the bladder could scarcely be seen to contract."

"I rejoice to find that you were so observant," said his father: "the effect you noticed depended upon a general law of elasticity. Elastic bodies, in the recovery of their forms from a state of compression, after the removal of the compressing force, exert a greater power at first than at last, so that the whole progress of restoration is a *retarded* motion."

The vicar, who had listened with profound attention to the



explanation which the boy had offered, rushed forward at its conclusion, and clasping him in his arms, declared, that a first-class man of Trinity could not have succeeded better.

"But let us now, if you please, Mr. Seymour, suspend our researches: recollect," said the vicar, "that your birds are, as yet, scarcely fledged; and they will, therefore, make greater advances by short flights frequently repeated, than by uninterrupted progression."

We heartily concur in this opinion, and shall, therefore, terminate the chapter.



## CHAPTER IV.

THE REVOLVING WATCH-GLASS.—THE SLING.—THE CENTRIFUGAL AND CENTRIPETAL FORCES.—THEORY OF PROJECTILES.  
—THE TRUNDLING OF A MOP.—THE CENTRIFUGAL RAILWAY.

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ON the following morning Mr. Seymour proceeded to explain the nature of "COMPOUND FORCES." The young party having assembled as usual, their father commenced his lecture by reminding them that the motion of a body actuated by a *single* force was always in a right line, and in the direction in which it received the impulse.

"Do you mean to say, papa, that a single force can never make a body move round, or in a crooked direction; if so, how is it that my ball or marble will frequently run along the ground in a curved direction? indeed, I always find it very difficult to make it go straight."

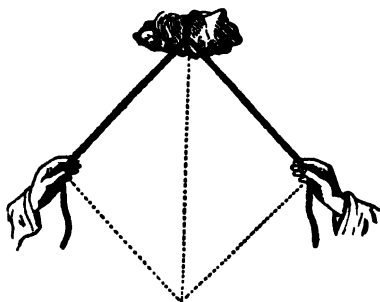
"Depend upon it, my dear, whenever the direction of a moving body deviates from a straight line, it has been influenced by some second force."

"Then I suppose that, whenever my marble runs in a curved line, there must be some second force to make it do so."

"Undoubtedly; the inequality of the ground may give it a new direction; which, when combined with the original force which it received from your hand, will fully explain the irregularity of its course. It is to the consideration of such compound motion that I am now desirous of directing your attention: the subject is termed the 'COMPOSITION OF

FORCES.' Here is a block of wood, with two strings, as you may perceive, affixed to it: do you take hold of one of these strings, Louisa; and you, Tom, of the other. That is right. Now place the block at one of the corners or *angles* of the table: and while Tom draws it along one of its sides, do you, Louisa, at the same time, draw it along the other."

The children obeyed their father's directions.

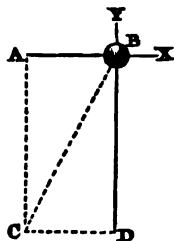


"See!" said Mr. Seymour, "the block obeys neither of the strings, but picks out for itself a path which is intermediate. Can you tell me, Tom, the exact direction which it takes?"

"If we consider this table as a parallelogram, I should say, that the block described the diagonal."

"Well said, my boy; the ablest mathematician could not have given a more correct answer. The block was actuated by two forces at the same time; and, since it could not move in two directions at once, it moved under the *compound* force, in a mean or diagonal direction, proportioned to the influence of the joint forces acting upon it. You will, therefore, be pleased to remember, it is a general law, that where a body is actuated by two forces at the same time, whose directions are inclined to each other, at any angle whatever, it will not obey either of them, but move along the diagonal. In determining, therefore, the course which a body will describe under the influence of two such forces, we have

nothing more to do than to draw lines which show the direction and quantity of the two forces, and then to complete the parallelogram by parallel lines, and its diagonal will be the path of the body. I have here a diagram which may render the subject more intelligible. Suppose the ball *B* were, at the same moment, struck by two forces *x* and *y* in the directions *B A* and *B D*. It is evident that the ball would not obey either of such forces, but would move along the oblique or diagonal line *B C*."



"But," said Tom, "why have you drawn the line *B D* so much longer than *B A*?"

"I am glad you have asked that question. Lines are intended, not only to represent the direction, but the *momenta* or quantities of the forces: the line *B D* is, as you observe, twice as long as *B A*; it consequently denotes that the force *y* acting in the direction *B D* is twice as great as the force *x* acting in the direction *B A*. Having learned the direction which the body will take when influenced by joint forces of this kind, can you tell me the relative time which it would require for the performance of its diagonal journey?"

Tom hesitated; and Mr. Seymour relieved his embarrassment by informing him, that it would pass along the diagonal in exactly the same space of time that it would have required to traverse either of the sides of the parallelogram, had but one force been applied. Thus, the ball *B* would reach *C* in the same time that the force *x* would have sent it to *A*, or the force *y* to *D*. "I will endeavor to prove this fact beyond all doubt. It is, I think, evident, that the force which acts in the direction *B A* can neither accelerate nor retard the approach of the body to the line *D C*, which is parallel to it; hence it will arrive at *C* in the same time that it would have done had no motion been communicated to it in the direction *B A*. In like manner, the motion in the direction *B D* can neither make the body approach to nor recede from *A C*; and

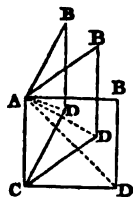
it therefore follows, that, in consequence of the two motions, the body will be found both in  $A C$  and  $O D$ , and will, therefore be found in  $O$ , the point of intersection."

Louisa seemed to express by her looks the irksomeness of such demonstrations; and which did not pass unobserved.

"This may appear tedious and uninteresting," said Mr. Seymour, "but the information is absolutely essential to our future progress: if you would reap, you must sow."

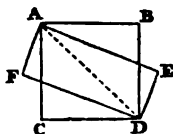
Tom and Louisa both expressed themselves willing to receive whatever instruction their father might consider necessary: and they further declared, that they understood the demonstration he had just offered them.

"Is it not then evident," proceeded Mr. Seymour, "that the composition of forces must always be attended with loss of power; since the diagonal of a parallelogram can never, under any circumstances, be equal to two of its sides? and is it not also evident, that the length of the diagonal must diminish as the angles of the sides increase; so that the more acute the angle at which the forces act, the less must be the loss by composition? But I shall be better able to explain this law by a diagram. If  $B A$ ,  $A C$  be the sides of a parallelogram representing the direction of two forces, and  $A D$  the diagonal path of the body, is it not evident that the line  $A D$  will shorten as the angle  $B A C$  increases?"



"We see that at once," cried Tom, "from the diagram before us."

"Then we will proceed to another fact connected with the same subject. Look at this diagram; is not the diagonal  $A D$  common to both the parallelograms inscribed about it, viz., of  $A B O D$ , and  $A E F D$ ?"



"To be sure it is."

"Then it is equally clear, that a body may be made to tra-

verse the same path  $\Delta D$ , by any pair of forces represented by the adjacent sides of either of such parallelograms."

"Undoubtedly."

"I request you to keep that fact in your recollection."

"I have now to inform you," continued he, "that a single force may be resolved into any number of forces, and may, in fact, be regarded as compounded of innumerable oblique ones. In order, however, to render this fact more intelligible, I must refer you to the same figure, from which it will appear that the motion of a body, along the line  $\Delta D$ , will be the same whether it arise from one single force acting in that direction, or from two forces impressed upon it in the directions  $\Delta E$ ,  $\Delta C$ , or in those of  $\Delta E$ ,  $\Delta F$ ; and, consequently, although the motion may, in reality, be the effect of a single force, yet it may be considered as compounded of two or more in other directions, since the very same motion would arise from such a composition."

Tom acknowledged the truth of this statement; and Mr. Seymour assured him, that, when they came to play at ball and marbles, he should be able to give him a practical demonstration of the fact; for he would show him, that whenever a body strikes a surface obliquely, or in an inclined direction, such a *resolution of force* will actually take place: "and now, Tom," said his father, "give me a marble; for I wish to explain the reason why it turns round, or revolves on its axis, as it proceeds forward."

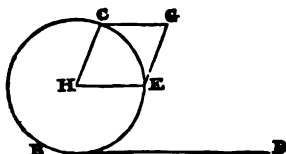
"I suppose," said Tom, "it depends upon the action which I give to it by my thumb and finger when I shoot it out of my hand."

"You are undoubtedly capable of thus giving to your marble a certain *spinning* motion, the effect of which we shall have to consider hereafter; but I fancy you would be greatly puzzled to make it proceed without revolving, give it what impulse you might by your hand."

"I have sometimes tried," said Tom, "to make it do so by pushing it along with a flat ruler, but it always *rolled* in spite of me."

"Then it is clear, from your own experiment, that its rotation cannot arise from the cause you would assign to it. If you will attend to this diagram," continued his father,

"I will endeavor to explain the operation. It is evident that, as the marble moves along the ground  $BD$ , the motion of the point  $B$  will be re-

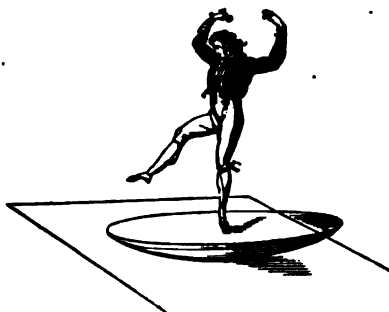


tarded by the resistance occasioned by its rubbing on the ground: while the point  $C$ , which does not meet with any such resistance, is carried forward without opposition, and it consequently must move faster than the point  $B$ ; but since all the parts of the marble cohere or stick together, the point  $C$  cannot move faster than  $B$ , unless the marble revolves from  $C$  to  $B$ ; and as the several points of the marble which are successively applied to the floor are retarded in their motion, while the opposite points move freely, the marble during its progressive motion must continue to revolve."

"But you said, papa, that whenever a body moved in any direction, except that of a straight line, it must have been acted upon by more than one force; and yet the marble not only runs along the ground, but turns round, at the same time, by the simple force of my hand."

"The revolution of the marble, my dear boy, is brought about by no less than three forces; look attentively at the diagram, and you will easily comprehend my explanation. There is, in the first place, the rectilinear motion given to it by your hand; then there is the friction of the ground: since, however, this latter acts in a contrary direction, it merely tends to lessen or counteract the velocity with which the under-surface proceeds, and consequently to give a relatively increased progressive motion to its upper part; then comes that force by which its several parts cohere, and which may be represented by  $CH$ ; so that the two forces producing the revolution of the point  $C$  are justly expressed by the lines  $CG$ ,  $CH$ ; but these are in the direction of the two sides of a par-

allelagram, the point will therefore move along the diagonal *o x*. I have here a toy for you, which will serve to explain



still further the causes of rotation to which I have alluded." Mr. Seymour produced a watch-glass, in the hollow of which stood a dancing-figure of thin card, as above represented.

He placed it upon a black japanned waiter,\* which he held in an inclined position, when it immediately slid down the inclined plane, as might have been expected. He next let fall a drop of water upon the waiter, and placed the watch-glass in it. Under this new arrangement, instead of sliding, the watch-glass began to revolve as soon as an inclination was given to the surface; and it continued to revolve with an accelerated velocity, obeying the inclination and position of the plane, as directed by the hand of the operator.

"What a very pretty effect is produced by the rapid revolution of the figure!" observed Louisa.

"Its use in the arrangement," said her father, "is to render the accelerated motion more obvious."

"I perceive it revolves faster and faster, or I suppose I ought to say, with an accelerated velocity," said Tom.

"Certainly," answered Mr. Seymour; "whenever a force

\* A common plate will answer the purpose; but the black surface gives the advantage of exhibiting more perfectly the motion of the water during the progress of the experiment.



continues to act, the motion produced by it must be accelerated for the reason already given you\*—but let me explain the operation of the drop of water, which, as you have just seen, converted the sliding into the revolving motion. In the first place, in consequence of the cohesion of the water to the two surfaces, a new force was introduced, by which an unequal degree of resistance was imparted to different portions of that part of the watch-glass in contact with the plane, and, consequently, in its effort to slide down, it necessarily revolved. Now, if you will attentively observe the change of figure which the drop of water undergoes during the revolution of the glass, you will perceive a species of vortex; a film of water, by capillary action, is drawn to the foremost portion of the glass, while, by the centrifugal force, a body of water is thrown under the hinder part of it; the effect of both these actions is to accelerate the rotatory motion.

"I shall now dismiss the subject for the present, but on some future occasion I shall probably revert to it; for it may be made to afford a simple illustration of the rotatory and progressive motions of the earth round the sun; and it may also give us the means of producing some optical effects of a very curious kind."

Mrs. Seymour here suggested that, as it was past one o'clock, the children should be dismissed to their more active sports in the garden.

"We will instantly proceed to the lawn," replied Mr. Seymour, "and Tom may try his skill with the *sling*; an amusement which I have provided as a reward for his industry, and which will, at the same time, convey some further information concerning the nature of those forces we have just been considering. The *sling*," continued his father, as he advanced upon the lawn, "consists, as you perceive, of a leathern thong, broadest in the middle, and tapering off gradually toward both ends. To each extremity is affixed a piece of string. I shall now place a stone in the broad part of the leather, and introduce my middle finger into the loop

\* See page 66.

formed in one of the strings, and hold the other extremity between my fore-finger and thumb."

He then whirled it round, and when it had gained sufficient impetus, he let go his hold of the string, and the stone instantly shot forth with amazing velocity.

"See! see! there it goes!" exclaimed Tom; "to what a height it ascended!"

"And to what a distance has it been projected!" observed Louisa, who had attentively watched its descent.

"Now, Tom," said his father, "can you explain the operation you have just witnessed?"

"Not exactly, papa."

"Then attend to me. Have you not learned that circular motion is always the result of two forces?"

"Undoubtedly," replied Tom; "of one force which attracts it to the center around which it moves, and of another which drives it off in a right line."

"Certainly; the former of these forces is therefore termed the *centripetal*, because it draws the body toward the center, while the latter is called the *centrifugal* force, since its influence disposes the body to fly off from the center. In circular motion, these two forces constantly balance each other; otherwise it is evident that the revolving body must either approach the center or recede from it, according as the one or the other prevailed. When I whirled round the sling, I imparted a projectile force to the stone, but it was prevented from flying off in consequence of the counteracting or *centripetal* force of the string; but the moment I let go my hold of this, the stone flew off in a right line: having been released from confinement to the fixed or central point, it was acted upon by one force only, and motion produced by a single force is, as you have just stated, always in a right line."

"But," observed Louisa, "the stone did not proceed in a straight, but in a curved line: I watched its direction from the moment it left the sling till it fell to the ground."

"You are perfectly correct," replied Mr. Seymour; "it described a curve, which is called a *parabola*; but that was

owing to the influence of a new force which came into play viz., that of gravity, the effect of which I shall have to explain hereafter."

"I cannot understand," said Tom, "why the stone should not have fallen out of the sling when you whirled it round over your head."

"Because, my dear, it was acted upon by the *centrifugal* force, which counteracted that of gravity; but I will render this fact more evident, by a very simple and beautiful experiment. I have here a wine-glass, around the rim of which I shall attach a piece of string so as to enable me to whirl it round. I will now fill it with water, and although during one part of its revolution it will be actually inverted, you will find that I shall not spill a single drop of water."

Mr. Seymour then whirled round the glass, and the young party were delighted with the confirmation thus afforded to their father's statement.

"I see," said Tom, "how it happened: when the glass was inverted the water could not fall out, because it was influenced by the centrifugal force which opposed gravity."\*

"Exactly. Have you ever observed what happens during the trundling of a mop? The threads which compose it fly off from the center, but being confined to it at one end they cannot part from it; while the water which they contain being unconfined is thrown off in right lines."

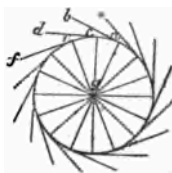
"I have certainly observed what you state," said Louisa; "the water flies off in all directions from the mop."

"Yes," added Tom, "the water was not acted upon by the *centripetal* force as the threads were, and consequently there was nothing to check the *centrifugal* force which carried the water off in a straight line from the center."

"You are not quite correct," said Mr. Seymour; "the water does not fly off in a right line from the center, but in

\* A more striking but fearful exemplification of this principle has been lately exhibited in London under the name of the CENTRIFUGAL RAILWAY, in which a car containing a passenger is made to descend from a lofty ceiling down an inclined railway, when, after whirling round in an inverted position it is carried forward to a corresponding elevation.

a right line in the direction in which it was moving at the instant of its release; the line which a body will always describe under such circumstances, is called a *tangent*, because it *touches* the circumference of the circle, and forms a right angle with a line drawn from that point of the circumference to the center; but I will render this subject more intelligible by a diagram. Suppose a body, revolving in the circle, was liberated at *a*, it would fly off in the direction *ab*; if at *c*, in that of *cd*; and if at *e*, in that of *ef*; and so on. Now, if you draw lines from these several points to the center of the circle, you will perceive that such lines will form, in each case, a right angle.

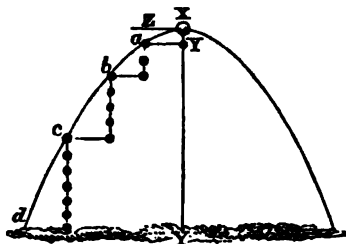


In the experiment which you have just witnessed, the surface of the water must have formed, during its revolution, a right angle with the string, and consequently could not have fallen out of the wine-glass. A knowledge of this law," continued Mr. Seymour, "will explain many appearances, which, although familiar, I dare say, have never been understood by you. You may remember accompanying me to the pottery, to see the operation of the turning-lathe; it was owing to the centrifugal force produced by the rotation of the wheel, that the clay, under a gentle pressure, swelled out so regularly; from a similar cause, the flour is thrown out of the revolving mill as fast as it ground; and I shall presently show you that you are indebted to this same force for the spinning of your top and the trundling of your hoop. But let us quit this subject for the present, and pursue the stone and its course after it is liberated from the sling. Louisa has justly observed that it described a curve; can you explain why it should deviate from a straight line?"

"Let me see," said Tom, thoughtfully; "it would be acted upon by two forces, one carrying it forward in a right line, the other bringing it to the earth: it would, therefore, not obey either, but describe a diagonal: but why that diagonal should be a curve I cannot exactly explain."

"Then I will give you the reason," said his father. "A stone projected into the air is acted upon by no less than three forces; the force of projection, which is communicated to it by the hand or the sling; the resistance of the air through which it passes, and which diminishes its velocity without changing its direction; and the force of gravity, which ultimately brings it to the ground. Now, since the power of gravity and the resistance of the air will always be greater than any force of projection we can give a body, the latter must be gradually overcome, and the body brought to the ground; but the stronger the projectile force, the longer will those powers be in subduing it, and the further will the body go before it falls. A shot fired from a cannon, for instance, will go much further than a stone thrown from your hand. Had the two forces which acted upon the stone, viz., those of projection and gravity, both produced uniform motion, the body must certainly have descended through the diagonal; but since gravity, as you have already learned, is an accelerating force, the body is made to describe a curve instead of a straight line. This law, however, will require the aid of a diagram for its explanation. Let  $x$  represent the ball at its greatest altitude,

$xy$  the force of gravity drawing it downward; and  $xz$  that of projection. We have here, then, two forces acting in the direction of the two sides of a parallelogram. In passing on to  $z$ , the ball will perform the diagonal  $xa$ ; and in the next equal space of time, will descend through *three* times the distance  $za$ , and will consequently be found at  $b$ ; while in the next period it will fall through *five* equal spaces, and pass to  $c$ ; and in the next period, again, as it must fall through *seven* such spaces, it will reach



the ground at  $d$ , having described the portion of a curve from  $x$  to  $d$ , or during the time that the two forces were in simultaneous operation. The same principle will explain the curved ascent of the ball, substituting only the laws of retarded for those of accelerated motion; for it is clear, that the body during its *ascent* will be retarded in the same degree in which it was accelerated during its *descent*."

"Your explanation," said Louisa, "appears very clear and satisfactory."

"The curve which *Projectiles* (that is to say, bodies projected into the air) describe, is termed a *Parabola*, although the resistance of the air, which is not recognized in the theory, produces a considerable influence on the practical result."

"I have only to add," said Mr. Seymour, "that although there exists an immense distance between a stone fastened to a cord, which a boy swings round, and those celestial bodies that revolve to all eternity, yet science proves that the source of their motions is identical."

The children now proceeded to amuse themselves with the sling. Louisa challenged Tom to a trial of skill. She fancied that she could hurl a stone with greater accuracy than her brother; but after several contests she acknowledged herself vanquished, for Tom had succeeded in striking the trunk of an old tree at a considerable distance, while his sister was never able to throw the stone within several yards of the mark.

"Well done, Tom!" exclaimed Mr. Seymour; "why, you will soon equal in skill the ancient natives of the Balearic Islands!

"And were they famous for this art?" asked Louisa.

"With such dexterity," replied her father, "did they use the sling, that we are told their young children were not allowed any food by their mothers, except that which they could fling down from the beam where it was placed aloft. I fancy, however, Tom, that you would become very hungry before you could strike an object in yonder poplar."

"At all events, I will try," said Tom.

He accordingly whirled round his sling, and discharged its stone, which flew forward with great velocity, but in a direction very wide from the mark at which it was aimed. In the next moment a violent hallooing was heard: it was from the vicar, who had narrowly escaped the boisterous salutation of the falling stone, which, in its anxiety to throw itself at the feet of the reverend gentleman, struck the beaver pent house that defended his upper story, and, by a resolution of forces which we have endeavored to explain, darted off in the direction of the side of a parallelogram, and was thus averted from the equally sensitive antipodes of his venerable person—his brains and corns.

"Upon my word, young gentleman!" cried the vicar, "I expected nothing less than the fate of the giant of Gath."

"My dear Mr. Twaddleton," exclaimed Tom, in a tone of alarm, "I sincerely hope that you have not been struck?"

"Oh no! like the Volscians of old, I bear my shield upon my head;\* so, thanks to my clerical hat, I have escaped the danger which threatened me: but, tell me, what new game is engaging your attention?"

Mr. Seymour said that he had been explaining the scientific principle of the sling, and that he hoped the vicar was prepared to afford them some information respecting its invention and history.

"The sling?" repeated the vicar; "why, bless me! I left you discoursing upon elasticity; you really stride over province after province as rapidly as if you were gifted with the seven-leagued boots of the Ogre:—but to the point in question. The art of slinging, or casting stones, is one of the highest antiquity, and was carried to a great degree of perfection among the Asiatic nations. It was well known and practiced at a very early period in Europe; and our Saxon ancestors appear to have been very expert in the use of this missile."

Mr. Twaddleton, being desirous of communicating the his-

\* *Æn.* lib. ix.



## CHAPTER V.

THE SUBJECT OF ROTATORY MOTION CONTINUED.—A BALL, BY HAVING A PECULIAR SPINNING MOTION IMPARTED TO IT, MAY BE MADE TO STOP SHORT, OR TO RETROGRADE, THOUGH IT MEETS NOT WITH ANY APPARENT OBSTACLE.—BILBOQUET, OR CUP AND BALL.—THE JOINT FORCES WHICH ENABLE THE BALANCER TO THROW UP AND CATCH HIS BALLS ON THE FULL GALLOP.—THE HOOP.—THE WHIP AND PEG TOP.—THE SLEEPING OF THE TOP EXPLAINED.

“Tom, do you remember that I told you a few days ago,” said Mr. Seymour, “that, by giving a revolving body a peculiar *spinning* motion, certain effects were produced, which I should, on some future occasion, take into consideration?”

“To be sure I do,” replied Tom.

“Well, then, attend to me.”



Mr. Seymour took a marble, and, placing it on the ground, gave it an impulse forward by pressing his fore-finger upon it: the marble darted forward a few paces, after which it rolled back again.

"That is most extraordinary!" cried Tom; "the marble came back to your hand, as it were, of its own accord, and without having met with any obstacle."

"And you, no doubt," said Mr. Seymour, "regard it as contrary to the well-known law, that a body once put in motion, in any direction, will continue to move in that direction until some foreign cause oppose it."

"It really would appear so."

"It is, however, far otherwise; the force which I imparted to the marble communicated to it two kinds of motion; the one projecting it forward, the other producing a rotatory motion round its axis, in a direction opposite to that of its rectilinear course; and the consequence was simply this, that when the former motion, on account of the friction of the marble on the ground, was destroyed, the rotatory motion continued, and, by thus establishing an action in an opposite direction, caused the marble to retrograde.\* If, however, you will fetch your hoop, I will demonstrate the fact on a larger scale."

Tom accordingly produced the hoop; and Mr. Seymour projected it forward, giving to it, at the same instant, a spinning motion in an opposite direction. The hoop proceeded forward to a certain distance, when it stopped, and then ran back to the hand.

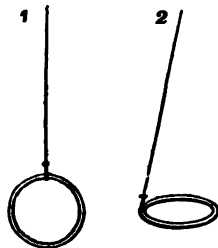
"Let me beg you," said Mr. Seymour, "to treasure this fact in your memory; you perceive by it how greatly the progressive direction of a body may be influenced by a rotatory motion around its axis; and, indeed, the theory of the *rifle* gun is easily deduced from it. It will also explain the effect which a rotatory motion produces in steadying or disturbing the direction of a projectile. It is for such a reason that the balancer constantly whirls round his balls or oranges,

\* This movement is well known to billiard players.

as he throws them into the air, with the intention of catching them again; and that in playing at *Bilboquet*, or cup and ball, you find it necessary to give a spinning motion to the ball, in order to catch it on the spike—but we will consider that subject presently. I shall also present you with a new missile which has lately found its way into the toyshops, termed the *BOMMERENE*. It is used by the natives of Australia, and has the curious property, when skillfully directed, after striking the desired object, to return to the thrower. I am now desirous of laying down a few propositions upon the subject of rotation, the knowledge of which is essential for the explanation of the motions of revolving bodies."

Mr. Seymour proceeded to state that every body had three principal axes upon which it might revolve, but that the shortest was the only one upon which it could permanently and steadily rotate; that should it, in consequence of the impulse given to it, begin to spin upon any other than the shortest axis, it would, during its revolutions, be constantly showing a tendency to approach it; whence it followed that, under such circumstances, it would be unsteady and *wabbling* in its motions.

In order, however, to make this proposition intelligible to the children, Mr. Seymour performed the following simple experiment.



Having tied some strings to a common curtain ring, as represented by figure 1, he twisted it round by means of his thumb and finger, until it acquired considerable velocity,

when the ring was seen to rise gradually into the position represented by figure 2. Thus, in the simplest manner, was a revolving body shown to exchange its longer for its shorter axis.

The children declared that they perfectly comprehended the subject, and Tom observed that, in future, whenever he wished to make a ball spin steadily, he should take care to make it turn on its shortest axis.

"You are quite right, Tom," said Mr. Seymour; "and the skillful bowler at cricket, in order to give his ball a steady axis of rotation, always holds it with the seam across, so that the tips of his fingers may touch, and he takes care to hold it only with such a grasp as may be sufficient to steady it, for by a turn even of the wrist it may be made to proceed unsteadily; and this leads me to consider another equally important proposition, viz., that the axis of rotation should coincide with the direction in which it is moving forward, or, in other words, with its line of motion. Now, where this is not the case, it is evident that the unequal action of the air will cause the body to deviate from its straight course, since its two sides, having different velocities (the rotatory and progressive motions conspiring on one side, while they are in opposition on the other), will be differently affected by such resistance; the resistance, of course, increasing with the velocity. It is upon this principle," continued Mr. Seymour, "that Sir Isaac Newton has explained the irregular motion of the tennis-ball."

"But do explain to us, papa," said Louisa, "why it is so necessary to spin the ball in order to catch it on the spike."

"Rotatory motion, my dear, when directed according to the principles I have endeavored to enforce, will always steady the course of a body. In playing at bilboquet, your object is so to throw up the ball that its hole may descend perpendicularly upon the spike which is held for its reception; and in order to accomplish this, you make the ball spin upon an axis, at the extremity of which is the hole; the consequence is obvious."

Louisa observed, that she well remembered an allusion to this game in Miss Edgeworth's *Essays on Education*; and that, unless she was much deceived, the advantage to be gained by spinning the ball was referred to centrifugal force, and its effect in preserving the "*parallelism of motion*."

"I do not recollect the passage," answered her father, "but I will admit that the centrifugal force is indirectly instrumental to the effect, although, in my view of the subject, it is more philosophical to refer it at once to the creation of an appropriate axis of rotation, and to the permanence of that axis maintained by rapid motion."

"I well remember," observed Tom, "that the rider at Astley's whirled round the oranges as he threw them into the air."

"And I hope that you are now not only acquainted with the principle which rendered such a rotatory motion necessary, but that which must make the shorter the more eligible axis for effecting his purpose;—but can you tell me how it could have happened, that the oranges, which were thrown perpendicularly upward while the horseman was on the full gallop, should have fallen again into his hand?"

"Ay," said Louisa, "that puzzled me exceedingly; I should have thought he would have ridden away from them, and that they must have fallen several feet behind him."

"What say you, Tom, to that?" inquired Mr. Seymour.

"I suppose that the rider calculated upon the distance he would pass forward before they could fall, and projected them accordingly."

"No, indeed; there is no calculation in the case, nor is any art used to throw the oranges in advance: they are projected perpendicularly from the hand; and if you will only recall to your mind the subject of the '*Composition of Forces*,' the mystery will vanish."

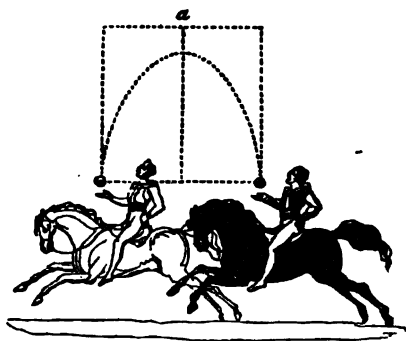
"I see it all clearly," cried Tom: "the orange partakes of the progressive motion of the rider; when, therefore, he throws it upward, it is influenced by two forces which are

in the direction of the two sides of a parallelogram, and it consequently describes the diagonal."

"You are quite right; but you doubtless will perceive that, instead of a straight line, the orange will describe a parabolic curve."

"For the same reason, I suppose," said Tom, "that the stone from the sling described a curve?"

"Certainly; but see, I have a diagram which will explain the subject more clearly."



"The orange, as it is thrown into the air, is influenced by two forces; the one arising from the progressive motion of the rider, the other from the projectile force imparted to it. These two forces are in the direction of the adjacent sides of a parallelogram, and were it not for the operation of gravity, the body would accordingly describe its diagonal in the same space of time as it would have described one of the sides.\* The influence of gravity, however, not only deflects it from a right line into a curve, but diminishes its force, so that, instead of arriving at the opposite angle of the parallelogram *a*, its greatest altitude will be short of that point; it will then descend through a similar curve; and, since the time of

ascent and descent are equal,\* it will reach the hand of the rider at the very moment he is prepared to receive it; for the orange will have traversed the parabolic curve in the same space of time as the horseman required for passing from one extremity of the curve to the other."

Mr. Seymour, having concluded this explanation, much to the satisfaction of the young party, observed that the present occasion was an appropriate one for the introduction of some remarks on the favorite pastime of the Hoop.

"It is a classical pastime," exclaimed the vicar, "and was as common with the Greeks and Romans as it is with boys of the present generation."

"And it has the advantage," added Mr. Seymour, "of sending the tide of life in healthful currents through the veins."

Tom began to trundle his hoop along the gravel-walk.

"Stop, stop, my dear boy," cried his father; "you seem to have forgotten our compact, that every toy should be fairly won before it was played with. Come upon the lawn, and let me ask you some questions relative to the motions of the hoop. Can you make it stand still upon its edge?"

"Not readily," was Tom's reply.

"And yet," continued Mr. Seymour, "during its progressive motion it rolls on its edge without any disposition to fall: how happens that?"

"It is owing to the centrifugal force, which gives it a motion in the direction of a *tangent* to the circle, and, consequently, overcomes the force of gravity."

"Your answer is pat," replied his father: "as long as you give your hoop a certain degree of velocity, the *tangential*, or centrifugal force, overcomes gravity, in the manner you have already witnessed;† but, when that is slackened, the hoop will fall on its side; not, however, until it has made several complete revolutions. Now, answer me another question. Why is it so difficult to make the hoop proceed straight forward, without turning to the right or left?"

"I suppose it arises from the same cause as that which altered the direction of my marble as it ran along—the inequality of the ground."

"That," replied his father, "would undoubtedly have its influence; but it is principally to be referred to the impossibility of your giving constantly a straight blow by the stick. When it is moving forward, a slight inclination toward either side will cause the parts to acquire a motion toward that side, those which are uppermost being most affected by it; and this lateral or sideways motion, assisted sometimes by the irregular curvature of the hoop, causes its path to deviate from a rectilinear direction; so that, instead of moving straight forward, it turns to that side toward which it began to incline; and, in this position, its tendency to fall is still further counteracted by the centrifugal force. It is from a similar cause that the bullet, unless rifled, will have a tendency to go to the right or left, from any unequal impulse which it may have received at the moment of its exit from the barrel. I have yet one other question, and, as its answer will lead us into the consideration of a mechanical subject of some importance, I must beg you to bestow all your attention. In trundling your hoop, have you not often observed that, although the blow inflicted upon it by your stick might have been violent, yet the effect produced by it was comparatively small, in consequence of the hoop having been struck by a disadvantageous part of the stick?"

"Certainly! I have frequently observed that, if the hoop is struck by the stick either too near the hand, or too near the end, much of its force is lost; and I have also noticed the same thing in striking the ball with my cricket-bat."

"The fact is," said Mr. Seymour, "that every striking body has what is termed its *center of percussion*, in which all the percussive force of a body is, as it were, collected; thus, a stick of a cylindrical figure, supposing the center of motion at the hand, will strike the greatest blow at a point about two-thirds of its length from the wrist. I may, perhaps, at some future time, return to this subject, and explain several

mechanical effects which are dependent upon it. Now away with you, and trundle your hoop, or spin your top; as soon as the vicar returns I will rejoin you."

"Stop a moment," cried the vicar; "do you not remember that the sword of Atrides in his conflict with Paris,\* as did also that of Turnus in his engagement with Æneas,† broke short and was shivered? And why so? Because, as we may suppose, the blow was struck at a point distant from the center of percussion, and so produced a jarring vibration that shattered the blade."

"Thus then it would appear, vicar, that the gods were unjustly accused of an unfair interference, and philosophy is again to be charged with clipping the wings of poetic fancy."

In the course of an hour Mr. Seymour and his reverend friend proceeded to the play-ground, where they found the children busily engaged in their several diversions.

"I rejoice to find you at so classical a pastime," said the vicar, as he approached Tom, who was busily engaged in spinning his top. "The top, my boy, is a subject which the great Mantuan bard did not consider beneath the patronage of his muse; but, hey-day! this is not the '*volitans sub verbere turbo*' of the immortal Virgil; the top of antiquity was the whip-top, the peg-top is a barbarous innovation of modern times: a practical proof of the degeneracy of the race. Even boys, forsooth, must now-a-days have their activity cramped by inventions to supersede labor: well may we regard the weapons, which our sturdy ancestors wielded, as instruments rather calculated for giants than men, if such pains be taken to instill into the minds of youth the mischievous spirit of idleness."

"My dear sir," said Tom, who was always grieved at displeasing the vicar, "if it will gratify you, I will spin my *whip-*

\* "The brittle sword, unfaithful to his lord,  
Broke short."—*Iliad* 3.

† "But all in pieces flies the traitor sword,  
And in the middle stroke deserts his lord."—*Æn.* 12.



top, for I have an excellent one which my papa has lately given me."

"Well said! my dear boy. '*Puer bonæ spei*.'—What a pity would it be to damp so noble a spirit! get your whip-top."

Tom accordingly placed the Virgilian top upon the ground, and as the boy plied the whip, so did the vicar lash the air with his quotation; running round the top in apparent ecstasy, while he repeated the well-known lines from the seventh *Æneid*:

"Ille actus habena  
Curvatis fertur spatii; stupet inscia turba,  
Impubesque manus, mirata volubile buxum:  
Dant animos plagæ."\*

As Mr. Twaddleton thus gave vent to that fervor which was ever kindled by collision with Virgil, Tom gave motion to his top, which swaggered about with such an air of self-importance, that, to the eye of fancy, it might have appeared as if proudly conscious of the encomiums that had been so liberally lavished upon it.

"The Grecian boys, as Suidas informs us, played also with this top," continued the vicar.

"And pray, may I ask," said Mr. Seymour, "whether it was not introduced into this country by the Romans?"

"Probably," replied the vicar. "Figures representing boys in the act of whipping their tops first appear in the marginal paintings of the manuscripts of the fourteenth century; at which period the form of the toy was the same as it is at present, and the manner of impelling it by the whip can admit of but little if any difference. In a manuscript† at the British Museum, I have read a very curious anecdote which refers to Prince Henry, the eldest son of James the First: with your permission I will relate it to you."

\* "The wooden engine flies and whirrs about,  
Admired, with clamors, of the beardless rout:  
They lash aloud; each other they provoke,  
And lend their little souls at every stroke."—DANIEL.

† Harl. lib. 1. marked 6391.

Here the vicar extracted a memorandum-book from his pocket, and read the following note :

"The first tyme that he, the prince, went to the towne of Sterling to meete the king, seeing a little without the gate of the towne a stack of corne, in proportion not unlike to a topp, wherewith he used to play, he said to some that were with him, 'Loe there is a goodly topp:' whereupon one of them saying, 'Why doe you not play with it then?' he answered, 'Set it up for me, and I will play with it.'"

"Was not that a clever retort of the young prince?" said the vicar, as he returned the manuscript into his memorandum-book; "and I think it must have confounded the courtier who could have asked so silly a question."

"Well, Tom," said Mr. Seymour, "let us see whether you can set up your own top, so that it shall stand steadily on its point."

"I have often tried that experiment," answered Tom, "but could never succeed in keeping the line of direction within its narrow base."

"And yet, when in rotatory motion, its erect position is maintained without difficulty: how is that?"

"Is it not owing to the centrifugal force?" asked Tom.

"Undoubtedly; but as the subject is highly interesting, I will endeavor to explain it more fully. You must, however, first obtain permission from the vicar to spin your humming-top, for that will better illustrate the phenomena which it is my wish to examine."

"If your object is the exercise of the body, let us spin the whip-top," replied the vicar; "but if you wish to exercise the boy's mind, I cannot object to your selecting the top best calculated to fulfill that desire."

Tom, having accordingly prepared his top, pulled the string, and set the wooden machine spinning on the floor.

"Now, Tom, I will explain to you the reason of the top being able to sustain its vertical position. You have already learned, from the action of the sling, that a body cannot move in a circular path without making an effort to fly off

in a right line from the center;\* so that, if a body be affixed to a string and whirled round by the hand, it will stretch it, and in a greater degree according as the circular motion is more rapid."

"Certainly," said Tom.

"The top, then, being in motion, all its parts tend to recede from the axis, and with greater force the more rapidly it revolves; hence it follows that these parts are like so many powers acting in a direction perpendicular to the axis; but, as they are all equal, and as they pass all round with rapidity by the rotation, the result must be that the top is in equilibrio on its point of support, or on the extremity of the axis on which it turns. But see, your top is down."

"And what is the reason," asked Tom, "of its motion being stopped?"

"I can answer that question, papa," said Louisa; "is it not owing to the friction of the ground?"

"Certainly; that has, doubtless, its influence, but the resistance of the air is also a powerful force upon this occasion. A top has been made to spin *in vacuo* as long as two hours and sixteen minutes.† But come, Tom, spin your top once more. Observe," exclaimed Mr. Seymour, "how obliquely the top is spinning. It is now gradually rising out of an oblique position;—now it is steadily spinning on a vertical axis;—and now its motion is so steady that it scarcely seems to move."

"It is *sleeping*,‡ as we call it," said Tom.

"Its center of gravity is now situated perpendicularly over its point of support, which is the extremity of the axis of ro-

\* Page 187.

† Short on "Serson's Horizontal Top." Phil. Trans. xlvii. 352.

‡ Plain matter-of-fact persons, like you and the author, gentle reader, will be content to regard the term "*sleeping*" as simply expressive of that quiescent state which the top thus assumes. Not so, however, Mr. Frybaird, who, smiling at our simplicity, informs us that the phrase is derived from the Italian word *topo*, a mouse, from which the Italian proverb, "*Il dormo come un topo*,"—He sleeps like a *dormouse*—has been corrupted into, "He sleeps like a *top*."

tation: but attend to me, continued Mr. Seymour, "for I am about to attempt the explanation of a phenomenon which has puzzled many older and wiser philosophers than yourselves. It is evident that the top, in rising from an oblique to a vertical position, must have its center of gravity raised; what can have been the force which effected this change?"

"Was it the centrifugal force?" asked Tom.

"Certainly not," said Mr. Seymour, "as I will presently convince you."

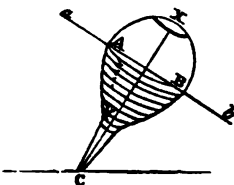
"Then it must have been the resistance of the air," said Louisa.

"No, nor was it the resistance of the air," replied her father; "for the same effect takes place *in vacuo*."

"Then pray inform us by what means the top was raised."

"It entirely depended upon the form of the extremity of the peg, and not upon any simple effect connected with the rotatory or centrifugal force of the top. I will first satisfy you that, were the peg to terminate in a fine, that is to say, in a *mathematical* point, the top never could raise itself. Let

$A B C$  be a top spinning in an oblique position, having the end of the peg, on which it spins, brought to a fine point. It will continue to spin in the direction in which it reaches the ground, without the least tendency to rise into a more vertical position; and it is by its



rotatory or centrifugal force that it is kept in this original position: for if we conceive the top divided into two equal parts  $A$  and  $B$ , by a plane passing through the line  $x c$ , and suppose that at any moment during its spinning the connection between these two parts were suddenly dissolved, then would any point in the part  $A$  fly off with the given force in the direction of the tangent, and any corresponding point in the part  $B$  with an equal force in an opposite direction; while, therefore, these two parts remain connected together,



Mr. Seymour, having observed his children busily engaged at the game of Trap and Ball, determined, as usual, to make it subservient to scientific instruction.

"Now, Tom, let me see how far you have profited by our late conversation. I have some questions to ask you about the action of your Trap and Ball," said his father.

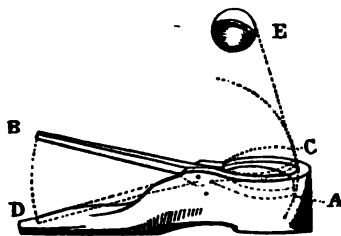
"I do not suppose there is much philosophy in the game," observed Tom.

"Of that we shall judge presently.—Can you tell me the direction which the ball takes after it flies from the spoon of the trap, in consequence of the blow of the bat upon the trigger?"

"It flies upward, to be sure, and allows me to strike it with my bat," answered the boy.

"Very true; but at what angle?—I see you hesitate; look therefore at the diagram I have prepared, and attend to my explanation of it."

Mr. Seymour produced the sketch which we here present to our readers.



"A B represent the spoon and trigger in their quiescent position. Upon striking the end B with the bat, they are brought into the position C D. The spoon will thus have described the small arc A C, when it will be suddenly stopped by the end of the trigger D coming into contact with the shoe. The motion of the ball, however, will not be arrested, and it will consequently be projected forward out of the spoon."

"Exactly," exclaimed Louisa, "in the same manner as the shilling flew off the wine-glass, or a person on a galloping horse would be thrown over the head by its suddenly stopping."

"I thank you, Louisa; your memory, I perceive, has not suffered from the drenching you received from the water-cart; —but can you tell me," continued Mr. Seymour, "the direction which the ball will take *after* its release from the spoon?"

This was a step beyond Louisa's knowledge, and her father, in order to assist her, begged her to consider in what direction it was moving *before* it left the spoon.

"You have just told us," said Tom, "that it described an arc, or portion of a circle."

"Very well," said Mr. Seymour; "and did not the philosophy of your sling teach you that, when a body revolving in a circle is suddenly disengaged, it will fly off in a right line in the direction in which it was moving at the instant of its release?—the ball therefore will describe the tangent *o z*."

"It is all clear enough to me now," said Tom, evidently vexed that he had overlooked a principle which had been so lately explained to him by the action of his sling.

"I now see, too," added Tom, "why the ball seldom flies off at the same angle in every trap."

"That," said his father, "must of course depend upon the extent of the arc described by the spoon, and which will of course vary in different traps."

"Before we conclude the subject, let me ask you whether there is not some one point in the bat, at which you can most effectually strike the ball?"

"To be sure," answered Tom, "in the same way that there is a point in my hoop-stick at which I can give the strongest blow—and that point is termed the *Center of Percussion*."

Now let us consider some other games of ball. One is the *harpastum*; a small ball, so called because the games-

ters endeavored to snatch it from each other. The ball was thrown unexpectedly to some one of the players, and he as unexpectedly threw it at another; hence it caused a variety of anxious and watchful movements."

"It seems," observed Louisa, "to be a sport better adapted to boys than girls."

"In that supposition you are quite mistaken," replied the vicar; "on the contrary, the hand-ball would seem to have been originally a female sport, for Homer has restricted the pastime to the princess and young maidens of Coreyra; at least, he has not mentioned its ever having been practiced by the men; but upon this point critics differ.

'O'er the green mead the sporting *virgins* play,  
Their shining veils unbound; along the skies,  
Toss'd and retoss'd, the ball incessant flies.'"

Mr. Seymour said that, as the vicar had satisfied them of the high antiquity of the ball, he hoped he would now afford them some information respecting its use in England.

"The game of hand-ball," said the vicar, "called by the French *palm-play*, because the exercise consisted originally in receiving the ball, and driving it back again with the *palm of the hand*, was formerly a favorite pastime among the youth of both sexes; and in many parts of the kingdom it was customary for them to play at this game during the Easter holidays for tansy cakes. In ancient times, the mayor and aldermen of Newcastle used to go in state at the feasts of Easter and Whitsuntide, to a little mall of the town, to witness this game. It was originally played with the naked hand; then with a glove, which in some instances was lined; afterward, cords and catgut strings were bound upon the hand to make the ball rebound more forcibly."

"That custom," observed Mr. Seymour, "doubtless, gave origin to the *racket*."

"It did," replied the vicar; "and the places where this game was played were called *tennis-courts*, and the game



itself obtained the name of *tennis*, from the French word *tenes*\* (take it, hold it), frequently used during the exercise. The pastime, I believe, was introduced among our ancestors about the year 1222, the sixth year of Henry III., by persons of superior rank and family, who erected courts or oblong edifices for the performance of the exercise."

"I long to hear something about foot-ball," exclaimed Tom.

"That is a pastime," said the vicar, "which was formerly in great vogue in England, but of late years it has fallen into disrepute, having apparently merged in the more popular game of *cricket*.† It derives its name, as you may suppose, from the circumstance of the ball being driven by the foot, in preference to the hand. When a match is made, two parties, equal in numbers, take the field, and stand between two goals, which are placed at the distance of eighty or a hundred yards from each other. The ball, which is commonly a blown bladder, cased with leather, is delivered in the midst of the ground, and the object of either party is to drive it through the goal of their opponents, by which the game is won. The abilities of the performers are best displayed in attacking and defending the goals, whence the pastime is more frequently called a *goal*, than a *game* at foot-ball. In this attack and defense, the exercise becomes exceedingly violent; the players kick each other's shins without the least ceremony; and this occasioned James I. to speak of foot-ball as '*meeter for laming than making able the users thereof*.'"

"I believe," said Mr. Seymour, "that the ancient game of *goff* is still much practiced in Scotland."

"It is," replied the vicar. "In the reign of Edward III.

\* This etymology has been disputed, and it has been said that the holding or keeping possession of the ball is no part of the game; for, during the play, the ball is in continual motion, or passing from one to another. Others seek the etymology of the name, and the origin of the game, in a place in France, called Tennols, or, by a change of one letter, Sennols, in the district of Champagne, where balls were first made, and the game, as it is said, first introduced.

† *Cricket*, from a Saxon word signifying a *stick*.

the Latin name *cambuca*, a crooked club, or staff, was applied to this pastime, because it was played with such an instrument. The bat was also styled a *bandy*, from its being-bent; and hence the game itself is frequently called *bandy-ball*."

"And how is it played?" asked Tom.

"It is played on a smooth common, by driving forward two small hard balls with the *bandy* I have just described, into very distant holes in the ground, about a foot deep, and nine inches over; and the party whose ball is driven into these holes with the fewest strokes is the victor."

"You have omitted to speak of that favorite game in the reign of Charles II., called *Pall Mall*," observed Mr. Seymour.

"I thank you for reminding me; it was a game played in a vista, now bearing the name of the *Mall*, in St. James's Park, at the end of which stood a pole, with a hoop suspended from an arm at its top, through which the ball was to be driven."

"But come," said Mr. Seymour, "it is high time to think of our dinner; the children must require some refreshment. I am not, my dear vicar, one of those philosophers who believe that play was invented by the Lydians\* as a remedy against hunger; nor do I subscribe to the opinion of the elder Scriblerus, that it was on such an account wisely contrived by Nature, that children who have the keenest appetites should, at the same time, be those who are most addicted to sport."

"Whether you believe or not that the Lydians invented sports shall not be a subject of contest between us," said the reverend antiquary; "but," continued he, "one thing is quite certain, that the Lydian games were at first called *Lydi* by the Romans; and afterwards by corruption *Ludi*; a presumption I must needs say in favor of the Lydian claim. But enough of this; to what do you propose we should next turn

\* Herodotus speaks of the inhabitants of Lydia having successfully had recourse to gaming as a partial substitute for food, during a famine of many years' continuance.

our attention? I doubt not you have some new sport for our recreation as well as our instruction," added the vicar.

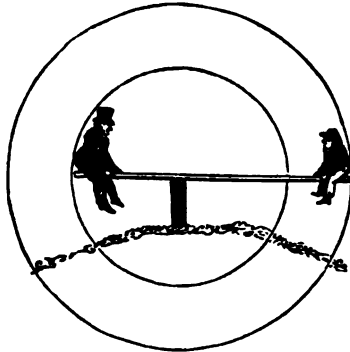
"We will, if you please, attend the children to their *see-saw*, which the gardener has lately constructed for them," said Mr. Seymour.

The party accordingly walked to the grove, in which a plank had been placed across a wooden post; and upon which Tom and John had been riding for some time in the earlier part of the morning. The boys again mounted their new hobby; and, after amusing themselves for some minutes, Mr. Seymour desired them to stop, in order that Tom might explain the principle upon which the *see-saw* acted. Tom replied, that he was not aware of any principle which could apply to riding on a plank.

"Have I not often told you, my dear boy, that the principles of Natural Philosophy may be brought to bear on the most trivial acts of life? Listen, therefore, and you shall find that your present amusement teems with instruction. You are already well acquainted with the nature and operations of the center of gravity; tell me, therefore, whereabouts it lies in the plank upon which you are riding."

"I should think," replied Tom, "that in this instance the centers of gravity and magnitude must coincide, or be very nearly in the same point."

"The center of gravity must, as you say, be very nearly in the middle of the board; and if that be the case, you will allow that, supposing those who ride upon it are of equal weight, the plank must be supported in the center to make the two arms equal; but you and John are of unequal weight, so that you perceive the plank must be drawn a little further over the prop to make the arms unequal; and John, who is the lighter, must be placed at the extremity of the longer arm. Thus arranged, you will exactly balance each other; and as each of you, on your descent, touches the ground with your feet, the reaction affords you a spring, which destroys the equilibrium, and enables you to oscillate in arcs about the center of motion."



"Do we then describe the arcs of a circle as we ascend and descend?"

"Undoubtedly you must. Look at this diagram," said Mr. Seymour, "and you will see at once that the plank can only move round its center of motion; for how could you rise, or your brother fall, perpendicularly in a straight line? You must, in rising, and he, in descending, describe arcs of your respective circles. It is equally evident that his velocity must be very superior to yours; for, if you could swing quite round, you would each complete your respective circles in the same time."

"It would really appear so," said Tom; "and I have myself observed that the lighter person has the better ride, as he moves both further and quicker, and I now understand the reason of it; it is because, being further from the center of motion, he describes a larger arc."

"The greater velocity with which your little brother moves, renders his momentum equal to yours. You have the most gravity, he the greatest velocity; so that, upon the whole, your momenta are equal: for you, no doubt, remember that momentum is weight multiplied into velocity.\* You have

here then a striking instance of mechanical advantage gained by opposing motion to matter, or velocity to weight; for I think you will readily admit, that, without the aid of the plank, your little brother could never have raised you from the ground."

"That is clear enough," said Tom.

"The plank, then, thus arranged," continued his father, "constitutes what has been termed a *mechanical power*, to which the name of *lever* has been given; it is not, however, my intention at present to enter into the history of these powers, of which there are six distinct kinds; the one presented to you, in the instance of the *see-saw*, is perhaps the most simple, and not the least important of them."

"It is very curious," observed the vicar, "to reflect upon what a simple, and apparently trifling fact, the powers of civilized man may be said to depend. The single truth you have just announced, of making velocity a compensation for weight, has supplied his weak arm with the means of controlling the very elements."

"It is very true," said Mr. Seymour; "and we might go so far as to say that, had it been the will of the Almighty Creator of the universe to have withheld from matter that property which we have been discussing, man must have remained the most helpless and forlorn of his creatures. I now propose," added Mr. Seymour, "to accompany the children to their swing; the present is a suitable opportunity for giving them some idea of the doctrine of oscillation, or the theory of the pendulum."

"Let us proceed, then, to the *Icarian Game*," exclaimed the vicar.

As the party walked along, Mr. Twaddleton explained the meaning of the above allusion, with which the reader will be hereafter made acquainted. The children had commenced the sport, and Mr. Seymour informed Tom and Louisa, who were attentively watching the motions of the swing, that its vibrations, like those of the pendulum of a clock, were produced by its effort to fall, from the force of gravity, and its power

of ascending through an arc similar and opposite to that through which it has descended, from the momentum acquired during its descent.

"Like the bandilor, I suppose," said Louisa.

"Exactly, my dear, that is a very good comparison; for as the bandilor, having descended along the string by its gravity, acquires such a momentum as to enable it to ascend the same string, and thus, as it were, to wind itself up; so does the pendulum or swing, during its descent, acquire a force that carries it up in an opposite arc to an equal height as that from which it had fallen. But tell me, Tom, whether you have not discovered that the motion of your new swing differs from that which you experienced in your former one?"

"The ropes of our present swing are so much longer than those which we formerly used, that the motion is much pleasanter."

"Is that all?" said Mr. Seymour. "Have you not observed that you also swing much slower?"

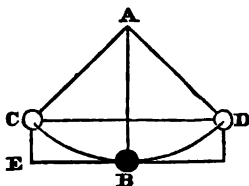
"I have certainly noticed that," said Tom.

"It is a law which I am desirous of impressing upon your memory, that the shorter the pendulum, or swing, the quicker are its motions, and *vice versa*; indeed, there is an established relation between the velocity and the length, which I shall hereafter endeavor to explain to you. Galileo, the celebrated philosopher, and mathematician to the Duke of Florence, accordingly proposed a method of ascertaining the height of the arched ceiling of a church by the vibrations of a lamp suspended from it. The solution of the problem was founded on the law to which I have just alluded, but which involves mathematical considerations, with which it is not my present intention to perplex you. Now it is known that, in the latitude of London, a pendulum, if 39 inches and two tenths in length, will vibrate seconds, or make 60 swings in a minute; by observing, therefore, how much the pendulous body deviates from this standard, we may, by the application of the appropriate rule, find its length; if the distance from the bot-

tom of the lamp to the pavement be then measured, which may be done by means of a stick, and added to the former result, the sum will give the height of the arch above the pavement; but I will show you the experiment the next time we go into Overton church; the vicar can tell us the exact height of the roof, and I will try how nearly I can approach the truth, by observing with a stop-watch how many seconds one vibration of the chandelier continues."

"But, papa, why, surely the duration of its vibration must depend upon the force which you may happen to give to the chandelier?"

"Not in the least; and this brings us at once to the consideration of the most curious and important fact in the history of the pendulum, and for a knowledge of which we are also indebted to Galileo.\* It is termed the *isochronous* property, or that by which all its vibrations, whether great or small, are performed in exactly the same period of time; but that you may be better able to comprehend this subject, attend to the diagram which I have prepared for your instruction. Suppose that the swing or pendulum  $AB$  be raised to  $C$ , it will, in effect, be raised the perpendicular height  $EC$ , and in falling will describe the arc  $CB$ ; and, in the point  $B$ , it will have that velocity which is acquired by descending through  $CB$ , or by a body falling freely through the perpendicular  $CB$ . This velocity will be sufficient to cause it to ascend through an equal arc  $BD$ , to the same height from whence it fell at  $C$ ; and since the times of ascent and descent are equal, it will describe both these arcs in exactly the same space of time. Having lost all its motion at  $D$ , it will again begin to descend



\* This discovery was published at Paris, in a treatise called "*L'Usage du Cadran, ou de l'Horloge Physique Universelle*," in the year 1639; from which may be dated the invention of the pendulum.

† Compounded of the Greek words *isos*, equal, and *chronos*, time.

by its own gravity; and in the lowest point *b* it will acquire the same velocity as before, which will cause it to reascend to *c*; and thus, by ascending and descending, it will perform continual vibrations in the circumference *c b c*; and, were it not for the resistance of the air, and the friction at the center of motion *a*, the vibrations would never cease; but from these obstructions, though small, it happens, that the velocity of the mass of matter at *b* is a little diminished in every vibration; and consequently it does not return precisely to the same points *c* or *b*, but the arcs described continually become shorter and shorter, till at length they grow insensible; and yet the very same time is required for the performance of the shorter as the longer arcs; for, although in the one case the body passes over less space, still its velocity is proportionally decreased. You perceive, then, that in an attempt to ascertain the height of a ceiling by the vibrations of a chandelier, the extent of its swing cannot alter the time which may be required for its completion. And, if you will place your little brother in the swing, you will perceive that he will return to your hand in nearly the same space of time, whether he describes a large or small arc; although this experiment must be considered as extremely rude, since there are many disturbing causes for which the theory cannot possibly make any allowance. I must, moreover, warn you that, where the arc described is very considerable, the difference in the time will be greater; for in order to insure this property of vibrating through unequal arcs in equal times, it is necessary that the path of the body should describe a peculiar curve, called a cycloid, and not the segment of a circle; at present, however, it is not possible for us to enter into this difficult branch of science, although I trust that at some future period I shall be justified in an attempt to explain it."

Mr. Seymour, having concluded his lecture, was about to return to the Lodge, when Mrs. Seymour approached the party, carrying in her hands a letter, which the smile on her countenance announced to contain agreeable intelligence.

"I have just received," said Mrs. Seymour, "a letter from



Miss Villers, whom you must all remember as a most delightful person. I am informed that she is about to be married to the nephew of a gentleman who is at present in our neighborhood in search of a country residence."

"Does she mention the gentleman's name?" inquired the vicar.

"Mr. Henry Beacham," said Mrs. Seymour.

"The nephew of Major Snapwell, I declare," exclaimed the delighted vicar.

The whole party participated in the pleasure which their excellent friend expressed at this discovery, and Mr. Seymour immediately accompanied Mr. Twaddleton to Ivy Lodge, to congratulate the major, and to make such arrangements as might expedite the purchase of Osterley Park, and the consequent introduction of a family into the neighborhood of Overton, from whose society the Seymours anticipated the highest satisfaction.

At the same time Mrs. Seymour hastened to dispatch a letter to Miss Villers, in order to solicit her immediate presence at Overton Lodge.





## CHAPTER VI.

MARBLER—ANTIQUITY OF THE GAME.—METHOD OF MANUFACTURING THEM.—RING-TAW.—MR. SEYMOUR, THE VICAR, AND TOM ENTER THE LISTS.—THE DEFEAT OF THE TWO FORMER COMBATANTS; THE TRIUMPH OF THE LATTER.—A PHILOSOPHICAL EXPLANATION OF THE SEVERAL MOVEMENTS.—THE RUDIMENTS OF THE STEAM-ENGINE FIRST APPEARED AS A TOY.—THE NATIVE CHILDREN OF THE ORINOCO PERFORM AN ELECTRICAL EXPERIMENT.—THE SUBJECT OF REFLECTED MOTION ILLUSTRATED.

IN our last chapter we left Mr. Seymour and his reverend friend on their way to Ivy Cottage: it is only necessary to state that the major received them with that satisfaction and gratitude which the nature of their visit could not fail to produce. Plans were proposed, and arrangements concluded, for the furtherance of the object we have announced; in

short, in the brief space of an hour, the major had determined the course of his future life, and had framed schemes of happiness, and visions of domestic peace, which he impatiently sought to realize. The vicar was detained by the major, but Mr. Seymour quitted Ivy Lodge and returned to his family. He found the children engaged at playing at marbles. Tom was displaying to his sisters many instances of his adroitness and skill in shooting at and hitting marbles.

"Why, Tom," exclaimed Mr. Seymour, "how came you possessed of such a multitude of marbles?"

"By luck, good luck, papa: I won them all before the holidays; and I can assure you that my school-fellows acknowledge me as one of the best players at *ring-taw* in the school."

"Justly, then, has your merit been rewarded," said the father. "Have you not read of the skillful Roman, who could blow peas through a quill, and deposit them with such nicety on the point of a pin, placed at some distance, as rarely to miss his aim?"

"And what was his reward?" asked Tom.

"A bushel of peas, my boy, which the emperor commanded to be presented to him. But do not misunderstand me; far be it from my wish to disparage your skill: whatever we undertake, we should endeavor to accomplish; I am, therefore, well pleased to find that you can play at marbles with so much success."

"I wonder who invented marbles," said Tom.

"That question, my dear, must be addressed to Mr. Twadleton, who, I have no doubt, will immediately answer it."

Scarcely had these words been spoken, when their "*Fidus Achates*" appeared on the lawn. Mr. Seymour informed him of the subject of their conversation, and added, that he had just told the children he was sure he would readily answer their question.

"Not so readily as you may imagine," replied the vicar; "but I will tell you all I know upon the subject. It appears to be a very ancient game; for it is stated by Suetonius, that

Augustus, when a youth, spent many hours in the day in playing with little Moorish boys '*cum nucibus*,' that is, *with nuts*, which appear to have been then used in the very way in which you now play with your marbles. In later times, round stones, picked out of gravel, were introduced for this purpose. The marbles which you now hold in your hand are substitutes of still more modern invention. The best of them are imported from Holland, where, as I have been informed, they are manufactured by grinding fragments of alabaster and of other stones, in an iron mill of a peculiar construction, in which there are several partitions furnished with rasps, which turn with great velocity, by means of a stream of water; and thus, having rounded the stones, project them out of different holes for which their size may adapt them. Thus manufactured, they are brought down the Rhine, and from thence dispersed throughout Europe; immense quantities are also exported to India and China. There are, however, as you well know, inferior kinds, which are of home manufacture, and consist of potter's clay, covered with a glaze, and burnt in a furnace."

"I have often wondered what is the meaning of the words *taw* and *ally*," observed Tom.

"Why, your *taw* is a brown marble, and your *ally*, if I remember rightly, a very white one: is it not so?" asked the vicar.

"To be sure," said Tom.

"Very well, then," said the vicar, "the words are clearly abbreviations of *tawny* and *alabaster*."

"Now then," said Mr. Seymour, "for a game; what is it to be, Tom?"

"*Ring-taw* forever!" cried Tom; "it is the only game of marbles worth playing at."

"It is really so long since I left school," observed his father, "that I must beg you to refresh my memory, and give me some instructions about this favorite game of yours."

"I will tell you all about it. We must first draw a circle, on which each player is to put a certain number of marbles to be previously agreed upon; we then make a mark at some

distance, which is called the *offing*, and from which we are to shoot at the marbles in the ring."

"That is all very intelligible," observed his father; "and I suppose the object of the player is to shoot a marble out of the ring, which not only gives him that marble, but entitles him to shoot again at another, and so on, until he misses, or all the marbles are won."

"That is right, papa."

"And a good marksman," observed the vicar, "who has the first shot, may easily win the game, before any other player can gain the opportunity of shooting at a single marble."

"I see that clearly," said Mr. Seymour; "he may strike out a marble from the circle, and then shoot at another, and in this manner traverse the whole ring; I therefore conclude that good players will always demand a large ring, or else there would not be much chance for any one, except for him who played first."

"That is the game; but I must tell you," said Tom, "that if the player should leave his own marble in the ring, he is at once put out; and should it be within a certain distance on the outside, an adversary may shoot at it, and, by hitting it, put him also out of the game."

"I believe that I am now a perfect master of the subject," said Mr. Seymour; "what say you, vicar?"

"I understand it; and it appears to me to be capable of some scientific calculation; but the practical results must, of course, differ very widely from the theory, for the unevenness of the ground, and the inaccurate construction of the marble, are circumstances which never can be duly estimated."

"Certainly not," replied Mr. Seymour; "these difficulties even exist at the game of billiards, where the table is smooth and perfectly horizontal: but we do not require perfect accuracy, an approximation to it will be sufficient for the purposes of illustration; we will, therefore, if you please, proceed at once to the game, and I will endeavor to point out to Tom the nature and direction of the several forces by which each marble will be influenced."

Tom, accordingly, like the son of Cornelius Scriblerus, converted his legs into a pair of compasses, and described, with the toe of his shoe, the necessary circle upon the ground. Each party, by agreement, placed two marbles upon the ring, and it fell to the lot of the vicar to open the campaign. Mr. Twaddleton then advanced, and, with the assumed air of a true knight-errant, approached the ring, exclaiming with a loud voice, and with a gesture of inexpressible drollery, "I demand gracious leave that I may be delivered of my vow, and forthwith combat in the lists;" so saying, he unfurled his red banner, and sounded a trumpet; or, in more humble phraseology, he extracted his handkerchief from his pocket, and, applying it to his nasal organs, produced a loud and thrilling blast, which frightened every sparrow from its resting-place. After this preliminary ceremonial, he marshaled his limbs into the most appropriate attitude, and, thrusting one hand behind the exuberant tail of his coat, he, with the other, shot forth his missile at the largest marble opposite to him. His *taw* faithfully delivered its errand, and inflicted such a blow upon the paunch of his antagonist, that, although nearly twice the size of its assailant, like a true bully, it skulked off, and retreated several feet beyond the lists; but, alas! the little marble of the vicar, unlucky wight! was so stunned by the operation, that it staggered, and reeled backward into the ring, and thus, according to the established law of the field, completed by one act the total defeat of its luckless commander.

"Your marble is left in the ring!" exclaimed Tom, with a shout of triumph.

"I see how it happened," said Mr. Seymour; "the vicar struck the marble plump, or 'played a full ball,' as we say at billiards, and the result easily admits of explanation. You already know that a marble possesses elasticity; when, therefore, the one in the ring was struck, it went off with a velocity equal to that with which the striking marble approached it, while the latter, in return, received a blow equal to that it gave, which destroyed its motion. When we go back into

the library, I will exhibit a very pretty experiment in further elucidation of this philosophical truth."

It was now Mr. Seymour's turn to enter the lists. He carefully applied his knuckles to the ground, and, taking aim at a little marble which he had selected as his victim, gallantly shot the missile from his thumb and finger; but, alas! alas! the goddess, whatever may be her name, who presides over this species of tourney, doubtless saw the impending fate of her favorite, and after the example of Venus, who turned aside the weapon from Æneas, assumed the shape of a small pebble, and thus arrested the fatal course of the marble, and gave it a new direction, which sent it curveting through the ring, without committing one single act of devastation.

"Bravo! bravo!" exclaimed Tom; "it is now my turn."

The boy, according to the usage of the field, might at once have won the game by striking his father's marble: but he was too magnanimous to take such an advantage, and too eager to display his own skill, to cut the game short by a maneuver: he had determined to win his laurels by hard fighting and generalship. He accordingly proceeded to strike a ring marble; in effecting which he had, like the vicar, challenged a *gigantic knight* as his antagonist; but instead of striking it *plump*, he struck its upper quarter, so that it was rolled out of the ring, while the striking marble, imparting only a portion of its momentum, continued to move forward after the impact. This course was greeted with the acclamations of Mr. Seymour and the vicar, the latter of whom declared it to have been "nobly run," and gallantly accomplished; and, extracting a sixpence from his waistcoat pocket, exclaimed, after the manner of chivalry, "*Largeesse, largeesse*, glory to the sons of the brave! glory to the invincible knight of the taw!"

The boy had not only struck the marble out of the ring, but he had, at the same time, contrived to place his own marble in the most favorable position for his future operations; and, indeed, it may be here observed, that in this con

sists the art of playing the game. It is almost unnecessary to add that Tom won every marble in succession.

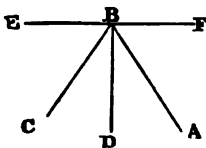
Mr. Seymour then proceeded to explain the laws of impact, by which the movement of each marble was directed. He observed, that the subject embraced two propositions, viz., the direction of the *object* marble after having been struck, and that of the *striking* marble after the stroke. He said that, if a straight line were drawn between the centers of the striking and object marbles, it would necessarily pass through their point of contact, and, if continued, would represent the path of the latter after the blow. In order to find the direction of the *striking* marble after the shock, he told him that he must imagine a tangent to the path of the *object* ball drawn from its center, and then a line parallel to it, from the center of the striking marble; the latter of which would be the required path.

Mr. Seymour now inquired whether there was any other game of marbles at which they could amuse themselves.

"The game which we call '*lagging out*,'" replied the boy, "is amusing enough. It consists in striking your marble against the wall, and making it rebound, so as to hit any other marble that is placed at a certain distance from it, or to come within a span of it."

"I understand," said his father, "and, like *ring-taw*, it may be made subservient to our purpose of illustrating the doctrine of forces; although I think that the principle of *reflected motion* may be more readily explained by the rebounding ball."

Mr. Seymour here took the elastic ball, and threw it obliquely against the wall, from which it rebounded in an opposite and equally oblique direction. He then sketched the annexed figure, and proceeded as follows:—"When I threw the ball against the wall B, in the direction A B, having struck it, it glanced off, making an angle, in its passage back again, equal





to that which it made in its approach to the wall. If I draw the perpendicular  $BD$ , this fact will be rendered more apparent, and you will perceive that the angle  $ABD$  is equal to the angle  $CBD$ ; the former is termed the *angle of incidence*, the latter the *angle of reflection*; and these angles, remember, are always equal, provided the ball under experiment be perfectly elastic."

"Do you mean to say," asked Tom, "that the more obliquely I throw the ball against the wall, the more obliquely it will rebound?"

"Exactly; that is my meaning; and see whether you cannot explain the fact, for it depends on the composition and resolution of the forces, a subject which I should hope you thoroughly understand."

Tom pondered for some time over the drawing, and at length observed that there was one difficulty which he could not immediately surmount.

"State your difficulty," said Mr. Seymour.

He proceeded to observe that the force acting in the direction  $AB$  would certainly be resolved into two others, viz., one in the direction  $FB$ , and another in that of  $DB$ ; "because," continued he, "these lines are the adjacent sides of the parallelogram, of which  $AB$  is the diagonal; and I well know that, whenever a force strikes obliquely, it is thus resolved."

"That is all very well explained," replied his father; "pray proceed."

"Now comes the difficulty," continued Tom; "for the force  $DB$  will of course be destroyed by the wall, and that represented by  $FB$ , which is the only one that can remain, would carry the ball to  $E$ ."

"It certainly would do so," answered his father, "if the ball were perfectly devoid of elasticity; but remember that, in consequence of this property, the force  $DB$  will be exchanged for one in an opposite direction,  $BD$ ."

"I had entirely overlooked the elasticity," said Tom; "I now see my way clearly, for in that case there must be two

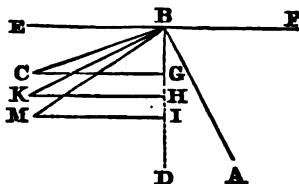
forces acting in the directions  $B D$ ,  $B E$ , which will, of course, drive the ball down the diagonal  $B O$ ."

"Your demonstration is perfectly correct, my boy; and I think you will now admit that I could not have adduced a more beautiful instance of the composition and resolution of forces; for, in the first place, you resolve the diagonal force into two others, and then you recompound these to produce another diagonal one."

"But I think you told us that the angles of incidence and reflection were only equal when the rebounding body was perfectly elastic."

“Clearly so; the force  $DB$  must be exchanged for an equal one  $BD$ , or else the angle  $ABD$  cannot be equal to the angle  $DBO$ ; but I will render this fact still further intelligible by another diagram. Let  $B$ , as in the former case, represent the wall upon which the imperfectly elastic body impinges in the direction  $AB$ .—The force will of course be resolved into two others, viz., into  $DB$  and  $FB$ ; the force  $DB$ , however, instead of being replaced by the opposite one  $BD$ , will now be represented by the shorter line  $B$

e; or that of  $BH$  or  $PI$ , according to the degree of elasticity. If we, therefore, complete the parallelogram,  $BC$ ,  $BE$ , or  $BM$  will be the diagonal path of the body; making, as you perceive, the *angle of reflection*



D B C, greater than that of incidence A B D; and where the body is perfectly inelastic, the force D B will be wholly destroyed, and, the force B E alone surviving, the body will be carried along the line B E. I have now," continued Mr. Seymour, "explained to you the principal laws which govern those forces by which your ball or marbles are actuated. It is true that in practice you cannot expect the results should accurately coincide with the theory, because, in the first place, you cannot obtain marbles that are of equal density

and elasticity, and of true figure; and in the next, there will be obstacles against which it is impossible to guard. The spinning of the marble will also have a material influence on its motion, as we have already discovered. In the game of billiards, where every obstacle is removed, as far as art can assist, the theory and practice are often strangely discordant. But we have dwelt sufficiently upon the subject; we will, therefore, return to the library, where I intend to exhibit an experiment in further elucidation of the subject of collision."

The party accordingly proceeded on their return.

"I hope," said Mr. Seymour, addressing himself to Mr. Twaddleton, who was walking a few paces before him, "that the maiden ladies have not espied their vicar at a game of marbles; if they should, what a chuckling would there be at their next tea party!"

"A fig for the spinsters!" exclaimed the vicar, as he hastily turned round, and arrested the progress of the party by his gesture. "You really speak, Mr. Seymour, as though it were derogatory to my character to descend from the more austere pursuits to the simple but innocent amusements of youth. Believe me, Sir, that I am not so old as to have forgotten that I was once young."

"Once young! say, ever young. I only lately observed, when you were playing with your ball and marbles, that they appeared to possess the power of restoring the vigor of youth, like the apples of the Scandinavian goddess Iduna," observed Mr. Seymour.

"And let me remind you," said the vicar, "that the Persian ambassador found even Agesilaus, the Lacedemonian monarch, riding on a stick."

"True; and the ambassadors of Henry the Fourth found him playing on the carpet with his children," said Mr. Seymour. "If you fall back upon authority, I am quite ready to stand as surety for your honorable acquittal. I suppose you remember that Socrates was partial to the recreation of riding on a wooden horse, for which, as Valerius Maximus informs us, his pupil Alcibiades laughed at him."

"I care not who laughs at me," exclaimed the vicar: "'the world may laugh again, and I may live to do it kindness.' I enjoy the amusements of youth, and am as willing as was old Æcestea to join their games.\* I entirely agree with Dr. Paley, in regarding the pleasure they afford as a striking instance of the beneficence of the Deity—

'Deus nobis hæc otia fecit,'

as Virgil has it."

The vicar proceeded in a strain of unusual animation—"Toys and games, my dear friend, have served to unbend the wise, to occupy the idle, to exercise the sedentary; and, let me add, to un wrinkle the aged, for, by reviving the pleasant recollections of youth, what a cheering glow is cast over the evening of life!"

"And," interposed Mr. Seymour, "I hope you will also add, to assist the young in acquiring knowledge, as well as to aid the sage in his labors to extend it; for I may here inform you that, by means of the soap-bubble, Faraday has succeeded in discovering new laws regarding the magnetic action of different gases."

"It might also be easily shown that the rudiments of the steam-engine first appeared in the form of a toy," observed the vicar.

"I suppose you allude to the *Eolipyle* of Hero of Alexandria?"

"Exactly so; and I have been told that our gas-lights were first suggested by boys filling the bowl of a tobacco-pipe with burning coal, and inflaming the vapor that issued from its tube."

Mr. Seymour here remarked that many of our valuable inventions were little less than cleverly developed toys, separated from each other, he was ready to admit, by no inconsiderable chasm; thus did Humboldt witness on the shores of the Orinoco the native copper-colored children of the forest amusing themselves by rubbing the dry, flat, shining reeds of

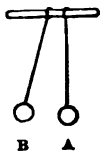
\* Æn., lib. v., ver. 712.

some leguminous plant, for the purpose of causing them to attract fibres of cotton, or bamboo; and he very philosophically exclaims, "How wide is the interval which separates this simple knowledge of electrical excitement by friction from the invention of the metallic conductor, the voltaic pile, and the magnetic telegraph!"

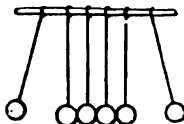
"All you have thus related," observed the vicar, "at least proves, what I am sure must afford you the highest satisfaction, that even these wild children of the forest entertained PHILOSOPHY IN SPORT."

The foregoing digression having been concluded, the party at once proceeded to the Lodge, where Mr. Seymour produced a piece of apparatus for the purpose of exhibiting the experiment he had promised, in illustration of the doctrine of the collision of elastic bodies.

"Here are two ivory balls," said he, "suspended by threads; I shall draw one of them, A, a little on one side; now I let it go, it strikes, you see, against the other ball, B, and drives it off to a distance equal to that through which the first ball fell; but the motion of A is stopped, because, when it struck B, it received in return a blow equal to that it gave, and its motion was



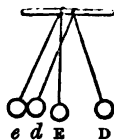
consequently destroyed. To extend the experiment, here are six ivory balls hanging in a row; I will draw the first out of the perpendicular and let it fall against the second; see! see! none of the balls appear to move except the last, which you perceive flies off as far as the first ball fell. I should like to hear you explain this."



Tom observed that, when the first ball struck the second, it received a blow in return, which destroyed its motion; and that the second ball, although it did not appear to move, must have struck against the third, the reaction of which set it at rest; that the action of the third ball must have been destroyed by the reaction of the fourth, and so on, until motion was com-

municated to the last ball, which, not being reacted upon, flew off.

Mr. Seymour commended Tom for his explanation; but he begged him to understand that such an effect only occurred when the balls were elastic; and he proceeded to exhibit the difference between elastic and inelastic bodies by another experiment. "When you raise one of these inelastic balls made of clay, out of the perpendicular, and let it fall against the other,  $x$ , the action and reaction, not being augmented by the force of elasticity, are insufficient to destroy the motion of the former; only part of the motion  $x$  will, therefore, be communicated to  $x$ , and the two balls will move together to  $d e$ , which are less distant from the vertical line than the ball was before it fell."



Before we close this chapter, we cannot resist the pleasure of informing our readers that Major Snapwell, in company with his legal adviser, had quitted Overton, for the purpose of making such preliminary arrangements as the purchase of an estate must necessarily require. It is not our intention to accompany them; nor shall we travel over the plains of parchment, nor wade through the rivers of ink, which separate the confines of verbal agreement and legal possession; but, claiming the prerogative of authors, we shall dip our wing in the cup of inspiration, and, by a single flourish of our feathered talisman, at once put the worthy major in the undisturbed possession of his newly-purchased mansion, and install him in one of Daw's most comfortable elbow-chairs, surrounded by all the luxuries of polished life.

The following morning was occupied with the consideration of those different toys which are indebted for their operation to the pressure of the atmosphere.

"Tom," said Mr. Seymour, "fetch hither your leathern sucker."

"John is, at this moment, amusing himself in the garden with the one which I brought with me from school," replied Tom.

"Then you shall construct another for yourself. Here is leather and string."

"This leather is too stiff; but I may, perhaps, make it answer the purpose by first soaking it."

Having allowed it to remain in water for a short time, the leather became sufficiently pliable for his purpose; he therefore cut it into a circular shape, and affixed a string through its center. The juvenile party now hastened to the lawn, and, having once again dipped his newly constructed sucker into the water, the ingenious boy placed it upon a stone, pressed down the leather with his foot, and succeeded in making it raise the weight.

"Well done, my boy! Now, then, explain the reason of the leather's adhesion to the surface, and of its being thus capable of retaining its hold, notwithstanding the gravity of the stone."

"In the first place," answered Tom, "the edges of the wet leather, from being closely pressed, stuck with sufficient firmness to the smooth surface of the stone, to resist the force of the string as I pulled it upward; the consequence was, that a hollow was formed in the middle part of the leather; and, as that hollow place cannot contain any air, it is called a *vacuum*."

"Very well," replied his father, "so far you are right; but you have not informed me in what manner a *vacuum* acts in preventing the stone from quitting the leather."

"It makes it adhere to it by some kind of *suction*, but I confess that I do not exactly understand the subject."

"Then let us proceed cautiously and deliberately in the explanation. In the first place, you have said, and said correctly, that the edges of the leather adhere to the stone; but what is the nature of the power to which this adhesion is to be referred? I perceive you are puzzled by the question: attend, then, to my explanation: you must know that there exists a tendency in all bodies to adhere together, provided the contact of their surfaces be sufficiently perfect; this property is termed *cohesion*, or cohesive attraction, from the Latin

word *cohereo*, which I need not inform you signifies to *stick together*. The dry leather will not adhere to a smooth surface, because, in that case, the contact cannot be rendered sufficiently perfect; but, when saturated with water, the interstices of the leather are filled with that fluid, and the inequalities of the surface, which must always prevent close contact, are removed. If two bodies, when placed together, be not sufficiently smooth, or polished, it will be vain to make any attempt to produce their cohesion; since the particles will, in such a state, touch each other only in a few points; whereas, if well polished, the number of points of contact is greatly increased, and the cohesion becomes very evident. It is for this reason that carpenters, when they intend to glue pieces of wood together, plane the surfaces perfectly smooth, before they apply the glue. In like manner, if two leaden bullets, having each a flat surface of a quarter of an inch in diameter, be scraped smooth, and then forcibly pressed together, they will cohere so strongly as to require the force of 100 lbs. to separate them."

Tom here acknowledged that he had not before understood the reason of the leather's adhesion to the stone.

"Having, then, settled this point to your satisfaction," continued Mr. Seymour, "let us proceed. Your idea of a *vacuum* being formed in the hollow part of the leather is perfectly correct: for, as you draw up the central part by the string, the hollow thus produced must necessarily be a *vacuum*, since the air cannot pass through the leather to supply it: in this state, therefore, the atmosphere presses upon the exterior of the leather, and like any other weight prevents its rising from the stone."

Fanny and Louisa here expressed some surprise, on hearing of the weight of the atmosphere: the former observed, that she did not feel any pressure from it. Their father explained the reason of their not being conscious of the weight, by informing them that their bodies contained air, which, by its elasticity, counteracted the pressure from without; but that, if it were possible to remove all the air which the body con-



tained, the pressure of the atmosphere would not be counteracted; and the consequence would be, that we should be flattened like a pancake by its weight, which had been ascertained by experiment to be equal to fifteen pounds upon every square inch of surface, or as much as forty thousand pounds upon the body of a man of ordinary size.

"Until your explanation," said Tom, "I really believed that the leather adhered to the stone by some kind of *suction*, just as the back of my hand adheres to my lips, whenever I place it to my mouth, and draw in my breath."

Mr. Seymour here expressed a doubt whether his son was even yet a perfect master of the subject: he told him that there was no such operation in nature as *suction*; that it was merely a popular term to denote the action of the air upon a vacuum. "Your hand," said he, "adheres to your mouth, in consequence of your forming a vacuum within it by forcibly drawing in your breath, and the resistance which is opposed to its removal arises entirely from the pressure of the atmosphere upon it. Many are the effects which may be explained upon a similar principle. I dare say you well remember the astonishment which you expressed at the force with which the limpets attached themselves to the rocks."

"O yes, papa," exclaimed Louisa, "I well remember when we walked on the sea-shore, that on first touching the limpets, they appeared loose and movable, but, before I had time to remove them, they fastened themselves as firmly as though they had been a part of the rock upon which they were fixed; how could that happen?"

Mr. Seymour replied, that these sea insects possessed the power of converting their whole bodies into *suckers*; and he informed them, that many other animals were endowed with a similar faculty. He instanced the claws of the polypus, which are furnished with many such suckers, by means of which the animal is enabled to hold to whatever it attaches itself, with very considerable force.

"Have you never observed," asked Mr. Seymour, "the security and ease with which flies frequently walk upon a

smooth wall, or a pane of glass, or even along the ceiling, with their bodies downward?"

"To be sure," replied Tom; "but are not their legs provided with some sticky matter, which enables them to preserve themselves from falling?"

At this moment Tom's stone fell from the sucker. Louisa inquired how it could have happened.

"The circumstance is to be easily explained," said her father. "The atmosphere, by its pressure, ultimately forced its way through the edges of the sucker; its interior, therefore, became filled with air, and it consequently balanced the external weight, which had before confined it."

"I have before alluded to the relative compressibility of air and water, and the present appears a good opportunity for proving the fact by an amusing experiment. See! here are the '*Bottle Imps*,' vicar, which you may remember I promised to introduce to your respectful notice," said Mr. Seymour. "In this jar of water, carefully closed, as you may perceive, by parchment, are two little enameled figures, which shall be made to rise and fall, by alternately pressing upon and removing the hand from the cover: thus."

"Why, the spirit of Simon Magus must surely possess thee!" exclaimed the vicar.

The children, as may be readily imagined, were much astonished at so singular an effect, and expressed much anxiety to be informed by what mechanism it was produced. Their father accordingly proceeded with the following explanation.

"I have here," said he, "a figure exactly similar to those in the bottle, which we will now examine. You will observe, that in its center there is a cavity terminating in a small orifice in the lower



part; this cavity may be made to contain any quantity of air, so as to give the required buoyancy to the figure: now mark!—I press my hand upon the parchment cover, and the figure, you perceive, descends; I now remove the pressure, and see, it immediately reascends. The water in the bottle, as I have told you, is incompressible; when, therefore, I press upon the surface, it rises into the interior of the figure, and, consequently, by compressing the air into a less space, renders it less buoyant; but no sooner is the hand removed, than the inclosed air resumes its former volume, and expels the intruding water; in consequence of which the figure regains its former lightness, and reascends. Do you understand me?" asked Mr. Seymour.

"Perfectly," said Tom, "and many thanks for the explanation;" and in this opinion did the whole party concur.

"Well, then," continued Mr. Seymour, "you will now understand the use of the air-bladder in fish, for it is constructed upon a precisely similar principle. When the fish desires to descend, it presses upon the bladder by means of its muscles, and thus condenses the included air into a smaller volume."<sup>\*</sup>

"I now also perceive why the water at the bottom of the sea cannot be much more dense than that on the surface; but, if we could dig a pit to the center of the earth, the air, in that case, would be highly dense, because, unlike water, it is compressible," said Tom.

"The density of the air," replied his father, "would, undoubtedly, materially increase as we descended. It has been calculated that at the distance of thirty miles below the surface, the air would have the same density as water; and at the depth of forty-two miles, that of quicksilver; while at the center it would be more solid than any substance of which we have any idea, for its density would be thousands of millions of times greater than that of mercury."

Mr. Seymour then informed his young pupils, that after the lesson they had just received they would never again be

<sup>\*</sup> In the cod-fish the air-bladder is familiarly called the *sownd*.

puzzled by the motions of the barometer, which had so often excited their wonder.

"As the quicksilver is contained in a closed tube, I do not exactly understand how the air can act upon it; and if the tube were not closed, it would of course run out from its weight," observed Louisa.

"You are altogether in error," said her father. "In the first place," he continued, "I will show you that the bulb at the lower extremity of the tube is open, in order that the quicksilver may freely communicate with the atmosphere, upon which, indeed, its action entirely depends; while the upper space is a perfect vacuum, so as to obviate any counteracting pressure. As to the quicksilver running out, have you so soon forgotten that the air presses upon every body on the surface of the earth, in the proportion of about fifteen pounds upon every square inch? Now it is from this circumstance that the column of quicksilver is sustained in the tube, the ascent and descent of which thus indicates the varying pressure of the atmosphere; so that, when the barometer falls, we know the air presses less heavily upon the earth, and the contrary when it rises."

"That I understand: but what can cause the pressure of the air to vary at different times?" asked Tom.

"Cannot you imagine the atmosphere to be an airy ocean, and to be therefore thrown into enormous waves, so that we may sometimes have a longer column of air above us than at other times? this is one explanation; there may be other causes not so intelligible," answered Mr. Seymour. "But enough of this for the present. Now, before we quit the subject of the air's elasticity, let us consider the philosophy of the *pop-gun*; an amusement with which, I have no doubt, you are well acquainted."

"Indeed I am, papa; but do you allude to the quill, or to the wooden pop-gun?"

"The principle in both is the same: tell me, therefore, the origin and nature of the force which enables you to shoot your pellet to so considerable a distance."

"It depends upon the action of the air," replied Tom.

"Undoubtedly; but your answer is too general; I wished you to state, in precise terms, the changes which the air undergoes upon this occasion. You first ram in your pellet to the further end of the tube, do you not?"

"To be sure; and then I drive in a second pellet, and, on forcing this forward, the first flies out with prodigious force."

"Very well: now examine what takes place. On propelling forward your second pellet, you condense the air which is inclosed between the two, until its elastic force becomes so great as to overcome the friction of the first pellet; thus released, the air expands with considerable force, and imparts a rapid motion to the pellet."

"I have frequently heard of the air-gun," said Louisa; "I suppose it depends upon a similar principle."

"It does; and it affords a very striking example of the surprising force which air is capable of exerting, when condensed to a considerable degree; for, by means of this instrument, bullets may be propelled with a force very nearly equal to that of gunpowder."

"It is a curious fact," observed the vicar, "that, although the air-pump is a modern invention, yet the air-gun, which is so nearly allied to it in the construction of its valves and condensing syringe, should have existed long antecedent to it; for it is recorded that an air-gun was made for Henry IV. by Marin, of Lisieux, in Normandy, as early as 1408; and another was preserved in the armory at Schmetau, bearing the date of 1474."

"But the air-gun of the present day," said Mr. Seymour, "is very different from that which was formerly made, and which, like the pop-gun, discharged but one bullet, and that after a long and tedious process of condensation; while it is now made to discharge five or six without any visible variation of force, and will even act upon a dozen, but with decreasing effect."

"I feel very curious to learn something more about this air-gun," said Tom.

"There is a reservoir for the condensed air," replied Mr. Seymour, "which is secured by a nicely constructed valve, and which is made to open by pulling the trigger of the gun, so that a portion only of the air is disengaged, which, rushing into the barrel, gives motion to the ball."

"But how is the condensed air introduced into the reservoir?" asked Tom.

"By means of a condensing syringe," replied his father; "but I will take an opportunity of exhibiting the instrument in operation."

The reader will be pleased to recollect that the major agreed to pay a passing visit to the vicarage; it now becomes our duty to record what happened upon that memorable occasion; and we, perhaps, cannot better represent the nature of the discussion that took place than by relating the account, as it was given by the belligerent parties themselves, in conversation with Mr. Seymour.

"Well, gentlemen," said Mr. Seymour, "is it peace or war? I trust you have amicably adjusted all your differences."

"Upon my word," answered the vicar, "I have just reason to complain of the major's unjustifiable skepticism upon points that are perfectly unquestionable."

"You continue then to smart under the major's stinging criticisms, '*majore sub hoste*.' There is a Latin pun for your consolation," said Mr. Seymour.

"The vicar alludes, I suppose," said the major, "to the doubt I expressed respecting the authenticity of his leathern money?"

"That is one of the many subjects upon which, I must say, you have betrayed a deficiency in historical knowledge. Seneca informs us that there was anciently stamped money of leather; and the same thing was put in practice by Frederick II. at the siege of Milan; to say nothing of an old tradition among ourselves, that, in the confused times of the barons' wars, the same expedient was practiced in England."



## CHAPTER VII.

**THE SOAP-BUBBLE.—THE SQUIRT.—THE BELLOWS; AN EXPLANATION OF THEIR SEVERAL PARTS.—BY WHOM THE INSTRUMENT WAS INVENTED.—THE SUCKING AND LIFTING, OR COMMON PUMP.—AN EXPERIMENT ILLUSTRATIVE OF ATMOSPHERIC PRESSURE.—THE MAGIC BOTTLE AND ITS WONDERS.**

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“Tom,” said his father, “bring me a saucer with some hot water; a piece of soap, and a tobacco-pipe. I have promised to teach John the art of blowing soap-bubbles.

“Most liquids, by agitation, exhibit the appearance of froth in consequence of the escape of the air in small bubbles, which had been forced into them by the operation. If, however,

the liquid be viscid and tenacious, like soap and water, the air is, as it were, imprisoned in the mass, producing the appearance which is commonly called *lather*."

Louisa here inquired "whether the air did not escape with more or less readiness, according to the degree of resistance it met with in the liquid?"

"I thank you," said Mr. Seymour, "for having so kindly assisted me in the explanation."

Louisa smiled at this mark of her father's approbation, and Mr. Seymour proceeded—"It is on that very account, that spirit, after it has been shaken, so soon regains its transparency: for, in consequence of the superior lightness of that fluid, and the little cohesion which subsists between its particles, the air makes a rapid escape. In like manner we may account for the spongy appearance which gives such superiority to our bread; in that case, the air disengaged during the fermentation of the dough cannot escape through so viscid a mass; it therefore remains, and thus produces the eyes or bubbles which you may always observe in every well-baked loaf."

"See, papa!" exclaimed Tom, "the bubbles which John has blown in the lather are not round, but angular figures—they appear to be like the hexagons which we used to cut out for our *papyro-plastics*."

"They are certainly hexagonal," replied Mr. Seymour; "and the form arises from the pressure of the bubbles upon each other. The same appearance is to be seen in the pith of vegetables, when examined by the microscope, and is the result of the general reaction of the solid parts upon each other; but let us proceed to blow some bubbles. Plunge the bowl of the tobacco-pipe into the lather."

Tom obeyed his father's directions, and blowing through the stem produced a bubble.

"See! see!" cried Louisa, "what a beautiful bubble! but there is a quantity of soap hanging to its under part."

"I will take it off with my finger," said Mr. Seymour.

"There it goes!" exclaimed Tom.



"What beautiful colors it displays! as bright and gaudy as those of the rainbow!" observed his sister.

"It has burst!" cried Louisa.

"Ah! my dear children," murmured the vicar, with an air of pensive gravity, "*Tenuis accessit in auras*," as the poet has it. Even thus it is with all the full-blown bubbles of our fancy, raised by the breath of hope; the moment they appear most vivid and promising to our imagination, they vanish 'into air, into thin air,' like the gaudy and unsubstantial soap-bubble you have just witnessed: but proceed to blow another."

"There is one!" exclaimed Louisa;—"see, it is of an oblong shape, like an egg!—there it goes!—but I declare it is now perfectly round!!—what can be the reason of its changing its figure?"

"I am glad you have asked that question, because my answer will serve to illustrate an important property of air, and which, indeed, is common to all fluids. While the upper part of the bubble was attached to the bowl of the pipe, its gravity, being resisted, drew it into an elliptical form; but the instant it was detached, the contained air pressed equally in all directions, and the bubble, in consequence, became a perfect sphere."\*

\* A scientific friend observed to the author that, as the globe possesses less surface than any other figure of equal capacity, it is of all forms that which is best calculated to allow the closest approximation of the particles of soap and water; and as there must exist among such particles a strong cohesive tendency, after having been forcibly stretched out, as it were, by the air blown into the bubble, it follows that, did no other cause operate, the bubble would assume the spherical form; in other words, that the effort of all the several particles of the mass to approach each other as closely as possible must result in the assumption of the spherical form. The same law governs the formation of the drops of water as they fall from the clouds, sparkle from the fountain, or glisten on the dewy foliage; and to avail ourselves of a beautiful instance of the alliance of science with poetry, we must be allowed to quote the following charming lines of Rogers:

"That very law which moulds a tear,  
And bids it trickle from its source—  
That law preserves the earth a sphere,  
And guides the planets in their course."

"I do not exactly understand what you mean by 'pressing equally in all directions.'"

"The expression is surely sufficiently intelligible. Did you not learn in our conversation of yesterday, that air has weight, and exerts a pressure as much upward as downward and laterally? Were this not the case, how could the air in the interior of our bodies counteract the pressure of the atmosphere? The form of the bubble proves the same fact in a different way; for, had the air in its cavity pressed more in any one direction than in another, the bubble could not have been round, or, to speak more correctly, a sphere?"

"What are you musing about?" cried the vicar, who had observed the attention of the boy riveted upon the bowl of the tobacco-pipe; "I am sure, from your countenance, that some circumstance is puzzling you."

"You are right, my dear sir; I was just then thinking how it can possibly happen that the bubble should not have a hole in its upper part; for, while I am blowing it up, there must, of course, be a communication between my mouth and its interior, or else how could the air pass into it?"

"True," said his father; "but the act of throwing it off from the bowl of the pipe will unite this breach; for there exists a strong cohesive attraction between the attenuated particles of the lather; you will, therefore, perceive that, on this account, the bubble will be more readily and securely separated by a lateral than a perpendicular motion of the pipe."

"I wish," said Tom, "that I could discover some method of preventing their bursting so soon, for there is scarcely time to examine them before they vanish. What can be the cause of their short duration?"

"Consider, my dear boy, the frailty of their structure, and I think that the precarious tenure of their existence will cease to astonish you; indeed, the wonder is, that they should endure so long. The film of which they consist is inconceivably thin,\* so that the slightest impulse will be apt to rupture it;

\* Not exceeding the two millionth part of an inch.

besides which, there must be a considerable evaporation going on from their surface, while the contraction of the contained air, from change of temperature, must also tend to limit their duration. You must likewise remember that the soap-lather will have a tendency to gravitate towards the depending part of the bubble, and, consequently, by quitting the upper portion, to render it of still greater tenuity. This last effect might, perhaps, be obviated, in some measure, by giving a rotatory motion to the bubble around its axis; but this, again, would accelerate the evaporation, which, after all, is the principal cause of the shortness of its duration; so that, unless this latter effect could be remedied, I despair of suggesting any expedient by which the frail existence of our airy structure could be protracted. You must, therefore, seek from a succession of bubbles, the prolongation of an amusement which no single one can afford you."

"And could not the evaporation be prevented?" asked Tom.

"If the bubble were blown in a glass vessel, and the latter immediately closed after the operation, it would remain for some time; I remember having once preserved a bubble in this manner for a very considerable period."

Tom, however, did not appear to relish this scheme; as, he said, the great sport arose from watching the movements of the floating bubble; the boy, accordingly, determined to pursue the amusement in the usual manner. His father, however, observed, that by mixing a solution of isinglass with the soap-lather, larger, as well as more lasting bubbles might be blown; and Tom accordingly determined to make the experiment.

During this dialogue, little John had succeeded, for the first time, in launching the airy bauble. Imagination always tinges the objects of our first efforts with brilliant tints; no wonder, therefore, that John, with a shout of ecstasy, should have pronounced it to have been the most beautiful bubble he had ever seen: in truth, the sun was shining brightly, and the colors thus produced very justly excited the admiration of all present.

"I cannot understand the cause of these beautiful colors," said Louisa.

Mr. Seymour expressed a fear that, in their present state of knowledge, they would be scarcely able to understand the explanation he should afford them. "But," said he, "I believe you know that a ray of light is divisible into seven colors, and that, when it passes through certain media, or is reflected from certain surfaces, this division is effected, and the various colors produced. The film of the soap-bubble is among the latter bodies; but I must refer you, for further information upon this subject, to Mrs. Marcet's beautiful Account of 'Refraction and Colors.'"

"Now, Tom," said his father, "fetch your squirt, for we have not yet finished our inquiry into the effects of the air's pressure."

The squirt was produced; but it was out of repair: for, on attempting to fill it with water, the instrument entirely failed in the performance of its office.

"I see the defect," said Mr. Seymour, "which a little string will easily remedy."

A piece of string was instantly produced from that universal depot, the breeches pocket of a schoolboy. Mr. Seymour said he should bind a portion of it around the end of the piston.

"What do you mean by the *piston*?" inquired Tom.

"The rod which moves up and down in the cylinder, or tube; and, unless its end fits so exactly as to prevent the admission of air, it is clear that the squirt cannot draw any water. It was for the purpose of making this part fit tightly that I wanted the string, and you will now perceive that the instrument is ready for use:—fetch me a vessel of water."

Tom soon produced the water, and, on placing it on the ground, requested that he might be allowed to fill the squirt. This he accordingly effected without difficulty, and, on pressing down the handle, he projected a stream of water to a considerable distance.

"I perceive," said Tom, "that the stream describes a curve, like my ball."

"To be sure; it is under the joint influence of the same forces, viz., those of projection and gravity. But explain the operation of the squirt."

"As soon as I raised the piston, an empty space was left in the lower part of the cylinder, which I suppose would have remained as a *vacuum*, had not the water rushed into it."

"And why did the water rush into it?"

Tom hesitated.

"Was it not, think you, owing to the pressure of the atmosphere upon the surface of the water? When you raised the piston, the air above it was also raised, and ultimately driven out by the force of the ascending piston; and since the air could not find any entrance from below as long as the point was under the water, the interior of the squirt would necessarily have remained quite empty, or have been a *vacuum*, had it not been for the weight of the atmosphere, which, not having any counteracting pressure, drove the water into the tube, and thus filled it; and which, by pressing down the piston, you again expelled with considerable force."

"Your explanation," cried Louisa, "is so clear and intelligible, that I feel quite confident I could now explain any machine that owes its action to the exhaustion of the air, and the pressure of the atmosphere."

"If that be your belief," said Mr. Seymour, "I will not lose a moment in putting your knowledge to the test.—Tom, do you run into the house, and fetch hither the kitchen bellows."

The bellows were produced, and Louisa, having been desired by her father to explain the manner in which they received and expelled the air, proceeded as follows: "Upon raising the upper from the under board, the interior space of the bellows is necessarily increased, and immediately supplied with an additional quantity of air, which is driven into it by the pressure of the atmosphere; when, by pressing down the upper board, it is again expelled through the iron tube or nozzle."

"To be sure," said Tom, "in the same manner that the water was expelled from my squirt, when I pushed down the handle."

"So far you are quite correct," said Mr. Seymour; "but you have not yet told us the use of the hole\* in the under-board, and which is covered, as you perceive, with a movable flap of leather: it is termed a valve, or '*wind-clap*.'"

"That," replied Tom, "is for the purpose of admitting the air, when we raise up the board."

"Exactly so; and also to prevent the air from passing out again, when you press it down. I wish to direct your attention particularly to this contrivance, because, simple as it may appear, its action will teach you the general nature of a valve. Without it, the operation of filling the bellows with air would have been so tedious as to have destroyed the utility of the instrument; for the air could, in that case, have only found admission through the nozzle, and that, again, would have been attended with the additional disadvantage of drawing smoke and other matter into its cavity; when, however, you raise up the board, the air, by its external pressure, opens the wind-clap inward, and thus finds an easy entrance for itself; and when you press the board downward, the air, thus condensed, completely shuts the valve, and, its return through that avenue being prevented, it rushes out through the tube."

The children were much pleased with the simplicity of this invention, and Tom inquired of the vicar who first thought of it.

"We are informed by Strabo," replied Mr. Twaddleton, "that Anacharsis, the Scythian philosopher, who lived in the time of Solon, about six hundred years before Christ, invented the bellows, as well as the anchor and potter's wheel; but," he added, "there is some reason to doubt the truth of this statement. The bellows, however, were certainly known to

\* A story is told of a young student, less intelligent of course than Tom Seymour, who, upon being asked the use of this hole, answered, "*for the reception of the knee while blowing the fire.*"

the Greeks; and the great poet Virgil alludes to them in his fourth *Georgic* :\*  
‘————— *Alii taurinis follibus auras*  
*Accipiunt redduntque.*’ ”

Mr. Seymour now proposed that they should proceed to consider the structure and operation of the pump.

“I suppose,” said Louisa, “that the pump raises water in the same manner as the squirt.”

“Exactly upon the same principle,” replied her father; “but the machinery is a little more complicated, since its object is not to force the water out of the pump at the same end of the pipe at which we draw it in. We will, however, proceed to the stable-yard, and examine the pump; and do you, Tom, provide a piece of chalk, in order that I may make a sketch of some of its principal parts.”

The party immediately proceeded; and, as they walked along, Mr. Seymour desired the children to remember that the weight of the atmosphere was estimated at being equal to that of fifteen pounds upon every square inch of surface; and that the moment the water arrived at such a height as to balance that pressure, it could ascend no higher: he added, that the altitude at which such a balance took place was about 32 or 33 feet above the surface.

“If that be the case,” said Louisa, “the pump, of course, can never raise water from any well of greater depth than that which you state.”

“Not without some additional contrivance, which I shall afterward explain to you,” replied Mr. Seymour.

The party had, by this time, arrived at the pump; its door was opened, and as much of the apparatus exhibited as could be conveniently exposed. Mr. Seymour then chalked the annexed sketch upon the stable-door.

“Is that a pump?” asked Tom: “I should certainly never have guessed what you intended to represent.”

“It is not a perspective drawing, my dear, but a represen-

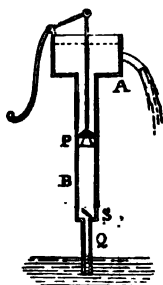
tation of the different parts as they would appear were it possible to cut the pump in halves, from top to bottom, without disturbing any of its arrangements. A drawing of this kind, which is frequently used for the sake of explanation, is termed a *section*."

Mr. Seymour here took an apple from his pocket, and, having cut it in two, observed that the surfaces thus exposed presented *sections* of the fruit. This illustration was understood by all present, and Mr. Seymour continued, "I have here, then, a section of the common household pump. *A B* is the cylinder or barrel; *P* the air-tight piston which moves or works within it by means of the rod; *Q* is the 'suction,' or 'feeding-pipe,' descending into a well, or any other reservoir; *s* the valve, or little door, at the bottom of the barrel, covering the top of the feeding-pipe; and there is a similar valve in the piston, both of which, opening upward, admit the water to rise through them, but prevent its returning. As this part of the apparatus is no less ingenious than it is important, I will sketch the valve, or *clack*, as it is termed by the engineer, on a larger scale."

Their father then chalked the annexed figure; from which its construction was rendered perfectly intelligible to the children.



Mr. Seymour proceeded: "When the pump is in a state of inaction, the two valves are closed by their own weight; but, on drawing up the piston *P*, from the bottom to the top of the barrel, the column of air, which rested upon it, is raised, and a vacuum is produced between the piston and the lower valves; the air beneath the valve, which is immediately over the surface of the water, consequently expands, and forces its way through it; the water then ascends into the pump. A few strokes of the handle totally exclude the air from the body of the pump, and fill it with water; which, having passed through both valves, runs out at the spout."





"I understand how water may be thus raised to the elevation of 32 feet, but I have yet to learn the manner in which 't can be raised above that distance," said Louisa.

"It is undoubtedly true that, if the distance from the surface of the water to the valve in the piston exceed 32 feet, water can never be forced into the barrel; but you will readily perceive that, when once the water has passed the piston-valve, it is no longer the pressure of the air which causes it to ascend; after that period it is raised by lifting it up, as you would raise it in a bucket, of which the piston formed the bottom; and water, having been so raised, cannot fall back again, in consequence of the valve, which is kept closed by its pressure. All, therefore, that is necessary, is to keep the working barrel within the limits of atmospheric pressure; we have then only to fix a continued straight pipe to the top of the barrel, and to lengthen the piston-rod in the same proportion, and the water will continue to rise at each successive stroke of the pump, until at length it will flow over the top of the pipe, or through a spout inserted in any part of its side. The common pump, therefore, is properly called the *sucking* and *lifting pump*."

The party expressed themselves fully satisfied; and Tom inquired who invented the machine.

"It is an instrument of great antiquity," replied his father: "its invention is generally ascribed to Ctesebes of Alexandria, who lived about 120 years before Christ; but the principle of its action was not understood for ages after its invention. The ancients entertained a belief that 'Nature *abhorred* a vacuum;' and they imagined that, when the piston ascended, the water immediately rushed forward to prevent the occurrence of this much dreaded vacuum. In the seventeenth century a pump was constructed at Florence, by which it was attempted to raise water from a well to a very considerable altitude, but it was found that no exertion of this machine could be made to raise it above 32 feet from its level. This unexpected embarrassment greatly puzzled the engineer, until Galileo suggested that the pressure on the water below must

cause its ascent into the pump, and that, according to this theory, when it had risen 82 feet, its pressure became equivalent to that of the atmosphere, and could not, therefore, rise any higher; and as they did not, at that time, understand the construction of the piston-valve, the design was abandoned."

"Before we quit this subject," added Mr. Seymour, "I wish to show you one or two experiments, in further elucidation of the effect of atmospheric pressure; but for this purpose we must return to the library."

As soon as the party had reassembled, Mr. Seymour, pointing to the preparations on the table, said they would readily perceive that he required but a very simple apparatus for the occasion;—"here, for instance, is a common glass tumbler filled with water, and I place over its mouth a piece of paper. I now invert it, and you see the paper does not fall off, nor does a single drop of water escape from the glass. I ask you, Tom, for an explanation."

"I suppose," answered the boy, "that the pressure of the atmosphere upon the paper kept it in its place."

"Undoubtedly; the external pressure of the air was greater than the gravitating force of the water; and I trust that, after the late explanation of the pump, you will readily perceive that this difference in favor of the atmospheric pressure must continue as long as the column of water does not exceed 82 feet."

"I understand that perfectly; but still I do not exactly see why the paper cover was necessary to keep the water in the tumbler."

His father informed him that, from the ample expanse of its mouth, the water, without such a guard, would at once have gushed out, and been replaced by the ascending air; whereas, had the mouth of the vessel terminated in a narrow neck, the paper might have been easily dispensed with; since in that case the small column of water would be unable to force a passage for itself through the contracted orifice, without undergoing a dispersion, and to that the cohesion of its particles would oppose an insuperable obstacle.

"Have you never observed the difficulty of drinking out of a vial?" asked his father.

"To be sure; very often at school, but I was never before able to account for it."

"We will now proceed to another experiment. I have here a lamp-glass, converted for the occasion, as you may perceive, into a water-bottle, by means of a cork inserted into its lower opening. I now propose, as in my former experiment, to fill it with water, and to place over its mouth a piece of paper, and then to invert it as before—observe! not a single drop of water escapes."

"Why, that is nothing more than a repetition of your former experiment," exclaimed Louisa.

"You are impatient, my dear girl; let me beg that you will wait, and observe what will follow."

"See! I now make a hole in the cork with your bodkin, and away pours out the water, sweeping the paper before it like a cataract. Can you explain this?" asked Mr. Seymour.

"I suppose," said Tom, "that the air, by rushing through the hole you made in the cork, pressed out the water by its weight, just as the pea was shot out of my pea-shooter."

"You have not answered my question with your accustomed consideration," said his father. "Let me ask you, how it is possible that the air thus admitted should possess any such power? Have you so far forgotten first principles as not to know that its internal pressure will be counterbalanced by the atmosphere on the exterior; and that, an equilibrium being thus obtained, we may exclude altogether the interfering influence of atmospheric pressure?"

"I see it all clearly now—by letting the air into the glass you equalized its pressure on the outside," said Tom.

"And, therefore," added his father, "the water, being thus left to follow an unobstructed course, did, in obedience to the universal law of gravity, flow out of the vessel."

"With the knowledge then that you have thus acquired, you will readily understand many things of daily occurrence, which might otherwise appear unaccountable; thus, for in-

stance, the vent-peg or *spigot* must be raised before the beer will flow out of the barrel. I allude more particularly to this example, as it will afford the simplest explanation of a very curious conjuring toy I have just obtained, and which I shall presently exhibit before you."

The children, as may be readily supposed, were much delighted by so exciting an announcement; nor were the vicar and Major Snapwell less curious to learn the nature of the proposed exhibition.

Mr. Seymour having rung the bell, a servant entered with a black pint bottle, and sundry small glasses, duly arranged on a waiter.—"I now propose to supply each of my guests, from the same magical bottle, with a glass of any wine he may call for," said Mr. Seymour.

The vicar preferred port and received it; the major required sherry, and his wish was gratified; Tom asked for some sweet wine, and he obtained it; and thus did Mr. Seymour proceed, successively filling five glasses, each with a different wine, from the same identical bottle.

"Bless my heart!" exclaimed the major; "I hope Mr. Seymour has not formed an unholy alliance with the Prince of Darkness; for it must be confessed he rivals the magic of Mephistopheles in the wine-vaults of Leipsig.\* At all events, let us beware how we spill a drop, lest it should turn to flame and consume us."

"Be not alarmed, my good and pious friends; as soon as I shall have described the ingenious construction of my bottle, its mysterious influence will be explained, and I shall be restored to your good opinion.

"This bottle," said Mr. Seymour, "is made of tin-plate, so japanned as to resemble a common wine-bottle. In its interior there are five compartments, each terminating in a small tube in the neck, with an orifice on the outside. These air-holes, having a connection with the cavities within, act like the vent-peg of the barrel, to which I have lately alluded. When, therefore, they are covered by the fingers, it is evident

\* Goethe's *Faust*.

that the liquid contents of the respective compartments cannot flow out of the bottle; but by raising each finger successively, we can command, at pleasure, the flow of any one of the liquids, in the manner you have witnessed."

Major Snapwell observed that he had frequently heard of this conjuring trick, as being one of the most surprising and successful efforts of M. Robin; whose wonderful art had lately elicited such general approbation from the sight-seers of London.

We must now conclude the philosophic amusements of this day. To-morrow we hope to enter upon the interesting subject of the *KITE*.





## CHAPTER VIII.

THE KITE.—ITS CONSTRUCTION.—THE TAIL.—AN AUTHOR'S  
MEDITATIONS AMONG THE CATACOMBS OF PATERNOSTER ROW.  
—THE VICAR'S DISMAY.—KITES CONSTRUCTED IN VARIOUS  
SHAPES.—ORIGIN OF THE NAME.—THE KITE OF CHINESE  
ORIGIN.—KITE-FLYING A NATIONAL PASTIME.—THE FIGURE  
USUALLY ADOPTED TO BE PREFERRED.

THE children were summoned into the library, and informed by their father that he was at leisure to explain the philosophy of the kite; a subject with which Tom had repeatedly expressed some impatience to become acquainted.

"It is a beautiful day," exclaimed the boy joyously; "and there is such a delightful breeze, that I should really call it a complete *kite-day*."

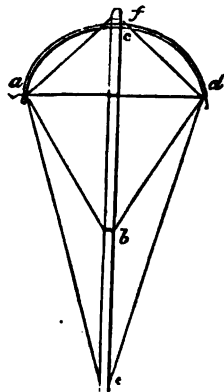
"Gently, my fine fellow," replied Mr. Seymour: "the bird must be fledged, ere it can fly. We have not, as yet, any kite; for you know that the one you possess is shattered beyond the possibility of repair."

"True, papa; but could not Robert just step into the village and buy one? I saw several kites in the shop of Peg Robeson yesterday."

"I do not doubt it, my boy; but the kites which are to be found in the toy-shop are made to sell, rather than to fly; we must, therefore, construct one for ourselves; and see! I have accordingly prepared all the necessary materials for the purpose. I have here, as you perceive, a straight lath of deal, about three-quarters of an inch wide, and less than a quarter of an inch thick, and about four feet in length; this is quite ready for forming the standard, or *back-bone* of the kite: and now for the bow. The cooper has complied with my directions, and sent an unbent hoop as free as possible from knots; you observe that it is about the same length as the lath, but it will be necessary to pare it down a little at each end, in order to make it bend more readily to the required shape."

This having been accomplished, Mr. Seymour proceeded to form the framework of the kite in the following manner. He first ascertained the central point of the bow, by balancing it on his fore-finger; he then affixed that point, by means of string, to the lath, at *c*, about an inch and a half from its upper extremity; a notch was next cut in each end of the hoop or bow *a d*; having fixed the string in the notch *a*, he drew it through another *a*, previously cut in the bottom of the lath, and carried it to the opposite end of the bow *d*; the skeleton now presented the usual form of the kite. The next point, therefore, was to ascertain whether the two sides of the bow were in equilibrium, which he determined by balancing the lath on the finger, and observing whether it remained horizontal, or dipped on either side.

This adjustment having been accomplished, Mr. Seymour next continued the string from *d* across the skeleton to the oppo-



site notch *a*, giving it one turn round the lath in its way; from *a* it was carried to *f*, and wound round the top of the lath, and then again fastened at *d*; from *d* it was extended rather more than midway down the lath, and having been secured at *b*, was finally carried to, and secured in the notch *a*. The framework was now pronounced by Mr. Seymour to be complete.\*

The next part of the process was to cover it with paper. Mr. Seymour observed that the best kind which could be employed for this purpose was that known among stationers by the name of *fan-paper*, so called from its being manufactured for the use of the fan-maker; its merits, he said, depended upon the size of its sheets, as well as upon the thinness and firmness of its texture: this, however, was not at hand; he was therefore obliged to rest satisfied with its best substitute, viz., folio sheets of large thin post.

The party now went "ding-dong" to work; paper, paste, and scissors were immediately put in requisition. Sheets of paper were laid smooth on the table, and so arranged that each sheet overlapped its neighbor about half an inch. The skeleton of the kite was then placed upon them, and the paper was cut to its figure; a margin, of about three-quarters of an inch, having been left around it, except over the bow, where the margin was extended to an inch in width: this arrangement was for the purpose of allowing the paper to turn over the framework, when pasted to it. This part of the work having been completed, and a sufficient time allowed for the drying of the paste, Mr. Seymour proceeded to fix the string, usually termed the *belly-band*: for this purpose two holes were drilled through the lath, at equal distances

\* The author has been thus minute, in order to afford his young friends clear directions for constructing a kite, and which, as far as he knows, are not to be found in any work hitherto published; and he will also avail himself of this opportunity to state, that the thin glazed linen of various colors, commonly known to haberdashers by the name of lining, has been found to be the best material as a covering for the kite. It is not only more durable than paper, defying the most boisterous wind, but superior to it as being secure from the effects of a shower of rain.



from its edges; the upper one about a fifth part of the length of the kite from the top, the lower hole rather more than the same distance above its extremity.

The last, and by far the most important point, was to make the loop in the *belly-band*. If the kite be accurately constructed, its proper place may be easily found by extending the band, right or left, on the surface of the kite, and then marking the string at a point which lies in a line drawn from one end of the bow to the other; the loop must be made a little above such a point. If the kite be now suspended by this loop, the two ends of the bow ought to preserve a balance, and the lower extremity should dip below the upper part of the kite.

As Louisa observed the extreme care with which her father adjusted this part of the machine, she inquired into its use.

"I was myself about to put the same question," said her mother; "for its adjustment would appear to require as much accuracy as that of the sash of a girl of sixteen."

Mr. Seymour informed them they would hereafter find that the steady ascent of the kite into the air entirely depended upon such accuracy. "Have you not seen, Tom," asked he, "a kite rise sideways, or *plunge*, as it is called?"

Tom said he had often experienced that difficulty at school, but that he had attributed it to some defect in the tail.

"An error in the construction of the tail may, certainly, be occasionally the cause of such an accident, but it is more generally referable to an improper position of the loop; if the kite *plunges*, you may conclude that this loop is placed too high; and should it whirl round in the air, you may infer that it is too low."

During this conversation Mr. Twaddleton entered the apartment; Tom was anxious to show him his newly constructed kite, and while the party were asking him numerous questions, Mr. Seymour observed that the vicar would be more profitably employed in making *boîte* for the string of the tail, than in finding answers for their string of questions.

Mrs. Seymour, and her daughters, with Tom and the vicar, were, accordingly, placed round the table, for the purpose of carrying this project into effect, by a suitable division of labor.

It was arranged that Mrs. Seymour should cut the paper, the vicar fold it, and Mr. Seymour tie it on the string.

"How long ought the tail to be?" asked Tom.

"And of what shape should the papers be cut?" inquired Louisa.

"And at what distances are they to be placed from each other on the string?" said Mrs. Seymour.

"I will answer all your queries," replied the father, "by giving you a dissertation upon this part of our machine."

"We shall now have an harangue," exclaimed the vicar, "as long as the tail itself; '*ut pueris placeas, et declamatio fias*,'\* as Juvenal has it—but pray proceed."

"The tail should never be less than twelve, and should it even amount to twenty times the length of the kite, its appearance in the air will be more graceful; this, however, must be regulated by the weight of the string, and by the length and thickness of the pieces of paper of which the tail is composed. The length of each ought to be about three inches and a quarter, and an inch and a half in breadth, and it should be folded four times longitudinally; each of these *bobs*, as they are called, must be placed at regular intervals of three inches."

"And with respect to the size of the wings?" asked the vicar.

"I should not recommend any wings; if the kite be well made, there cannot be any advantage from such appendages. Having now answered your several questions, let us proceed with our work."

"But where is the paper?" asked Mrs. Seymour.

"Apropos!" answered her husband; "the box in which the London toys were packed contains a quantity that will answer our purpose."

\* "That you may please the boys, and afford them a theme for declamation."—*Juv.* x. 167.

At this moment, Phoebus, as if delighted by the compliment thus bestowed upon his heathen brother, cast a shy glance from behind a dark cloud, and illumined the spot upon which the vicar was standing. In short, after the lapse of half an hour, the sun broke through the gloom, and a brisk gale followed; the countenances of the children sympathized with the face of the heavens, and the expression of hope lighted them up, in proportion as the sun illumined the departing clouds with its radiance.

"It is now quite fair, papa," cried Tom, in a voice of triumph, "and there is a most delightful wind: shall we not proceed at once to the common?"

"Presently," answered his father; "the ground is yet extremely wet."

In the course of an hour this objection had been removed, and the party prepared to set off on their kite-flying expedition.

"Bring me the kite, and let me sling it properly over Tom's shoulder," said Mr. Seymour.

"I will carry the string," exclaimed Louisa; "how nicely it is wound round the stick!"

On the arrival of the party at Overton Heath, the weather was found propitious to their adventure; the kite impatiently fluttered in the breeze, while Tom was eagerly engaged in unwinding its streaming tail, and preparing the paper machine for ascent.

"Is the string fixed to the belly-band?" asked Mr. Seymour.

"All is ready," replied the vicar; "and I will hold it up, while Tom runs with it against the wind. Had King Eric set his cap for us, we could not have had a more favorable breeze."

"There is not the least occasion to raise the kite from the ground," observed Mr. Seymour; "let its point rest on the grass, and place its tail in a straight line in front of it; I warrant you it will rise, as soon as Tom begins to run."

Tom immediately set off, and the kite rose majestically into the air.

"Give it string—give it string—gently, gently—now stop; there is no occasion for your running any further, but let out the cord, as long as the kite carries it off vigorously, and keeps it fully stretched; but wind it up the moment its tension is relaxed."

"It is rising very fast," cried the breathless boy, "but the string burns my hand as it passes through it; I shall not be able to endure the heat."

"Be patient, and let it pass more slowly; put on your glove," said his father.

"Ay, ay; put on your glove," repeated the vicar; "even Xenophon himself, who declaimed so warmly against the effeminacy of the Persians, for wearing gloves, would scarcely have refused his consent to their use on such an occasion."

"Nor did the old Grecian warrior, Laertes, disdain the protection of gloves against the thorns and thistles, while working in his garden,"\* added Mr. Seymour, to the no small satisfaction of his classical friend.

"What is it that produces so much heat?" inquired Louisa.

"The friction of the string," replied her father; "do you not know that carriages frequently catch fire from the friction of their wheels, unless it be prevented by the application of grease?"

"Yes," said Tom; "and I have heard that the natives of some countries kindle their fires by rubbing pieces of wood together."

"The original inhabitants of the new world," observed his father, "throughout the whole extent from Patagonia to Greenland, procured fire by rubbing pieces of hard and dry wood against each other, until they emitted sparks, or burst into flame; some of the people to the north of California produced the same effect by inserting a kind of pivot in the hole of a very thick plank, and causing it to revolve with extreme rapidity: the same principle will explain how immense forests may have been consumed; for it is evident, that the violent friction of the branches against each other from the agitation

\* Odysseus.

of the wind, would be fully adequate to the production of such an effect."

"You have also an excellent example of the effect of friction in producing heat," said the vicar, "in the history of the whale fishery; for, in harpooning the fish, unless the sailors observe the greatest caution in letting out the rope, its friction upon the side of their boat will be sure to set it on fire."

"And how do they manage it?" asked Louisa.

"As soon as the whale dives (4), after having been wounded, it draws out the line or cord of the harpoon, which is coiled up in the boat, with very considerable velocity. In order, therefore, to prevent any accident from the violence of this motion, one man is stationed with an axe to cut it asunder, if it should become entangled; while another, with a mop, is constantly cooling with water the channel through which it passes."

"The kite is now at a considerable height," observed Tom: "but look at the string, how bent it is! I have repeatedly endeavored to pull it straight, but without success."

"How could you have expected to succeed in the attempt? Consider the weight of such a long line of string."

"Then it is not the pressure of the atmosphere which gives it that curved form?"

"Assuredly not: have you so soon forgotten that the air presses equally in all directions, and would therefore tend to straighten, as much as to give a curved direction to the string? But, as you now appear to have let out the whole of your string, suppose you allow the kite to enjoy its airing, while we proceed to consider the philosophy of its ascent, and the nature and direction of those forces by which it is effected."

"The kite pulls so amazingly hard," cried Tom, "that unless I fix the string securely round the tree, we shall run the chance of losing it."

"I am well aware of the force it exerts," replied his father.

"Dr. Franklin has said, that, with a good kite, a man unable to swim might be sustained in the water, so as to pass from

Dover to Calais; but I agree with him in thinking, that a packet would be a much safer as well as a pleasanter mode of conveyance."

"Now, then, for your explanation of the kite's ascent. Unless I am mistaken, you will find the subject much more complicated than you imagine," said the vicar.

"Not at all; Tom, who, I trust, has a perfect acquaintance with the composition and resolution of forces, will very readily understand the explanation I propose to offer. I admit, however, that there are some few points in the inquiry, which cannot be successfully treated without a knowledge of the higher branches of mathematics; but I shall, of course, avoid all such difficulties.\* Can you tell me, Tom, what advantage is gained by your running with the kite?" asked Mr. Seymour.

"I suppose that you thus obtain more force from the wind."

"Certainly: action and reaction are equal. By running, therefore, with your kite against the wind, you strike the air, and thus produce a reaction, which is equal to the force of the blow given to it. When the wind is high, and its action is not intercepted by surrounding objects, there cannot exist any necessity for such an expedient."

"The principle is the same as that which enables the bird to rise into the air by flapping its wings," observed the vicar.

"Unquestionably," replied Mr. Seymour.

"Does the kite, then, rise in the air from the same causes that enable a bird to fly?" asked Tom.

"We are not at present considering the ascent of the kite, but the advantage which is obtained by running with it: this latter, as the vicar has properly observed, undoubtedly depends upon the same principle as that which enables the bird to rise, by the motion of its wings, and which constitutes the third law of motion,† viz., that *action and reaction are equal*;

\* Those readers, who are inclined to enter more deeply into the subject, may consult, with advantage, a memoir on the kite, by Euler, published in the Transactions of the Academy of Berlin for the year 1754.

† See p. 73.

that is to say, whenever one body exerts a force upon another, the second body opposes the first, with equal force, in an opposite direction. If, then, the bird strikes the air below it with a force which is equal to its weight, then must there be a reaction of the air, upward, exactly equal to it; and the bird, being acted upon by two equal forces, in opposite directions, will, necessarily, rest between them."

"That is clear enough, but the bird *rises*," answered Tom.

"Because the force of the stroke is *greater* than the weight of the bird, and it therefore rises with the *difference* of these two forces; were the stroke *less* than its weight, then would it sink with the difference. Suppose, for example, a bird weighs *twelve* ounces, and it strikes the air with a force equal to *sixteen*, is it not clear that it must rise with a force equal to *four*? and is it not evident that, if it strikes the air with a force equal only to *eight*, that it must sink with a force equal to *four*?"

"So far I understand it perfectly; but I was thinking that, as the wing flaps up and down, what was gained by striking the air downward must be counterbalanced when the bird raised her wing again, and thus struck the air in the contrary direction," observed Tom.

"I give you no small degree of credit for that remark," said his father; "for it is undoubtedly true that, if the flapping of the wings in flight were no more than the motion of the same surface upward and downward, the bird must lose as much by one motion as she could gain by the other: the skylark could never ascend by such an action, for, as you have so justly remarked, although the stroke upon the air by the under side of her wing would carry her up, the stroke from the upper side, when she raised her wing again, would bring her down; but if you will attentively examine the structure of the wing, you will at once perceive, from its external convexity, the disposition, and more particularly the overlapping of its larger feathers, that when the wing is drawn up, its surface is contracted, and when let down fully expanded—or, in other words, that the feathers strike the air downward

with their flat side, but rise from the stroke slantwise, just as the rower in a boat, after having given the stroke, turns his oar so as only to present its edge, an operation which is termed *feathering*, from its resemblance to this very action of the wing in flight."

"It appears to me that flying is an easy process," said Tom; "could we not contrive some sort of flapper, by which we might be able to rise into the air."

"Your opinion, my dear boy, is by no means singular; hundreds have entertained the same belief before you; and so confident was the famous Bishop Wilkins, that he declared it to be his conviction, that, in future ages, it will be as usual to hear a man call for his wings, as it is now to call for his boots."

"Yes," said the vicar; "and if my memory is correct, William of Malmesbury, in his account of the Conquest of England by the Normans, mentions a Benedictine monk, by the name of Elmer, who having affixed wings to his hands and feet, ascended a lofty tower whence he took his flight, but he fell to the ground and broke both his legs."—" *Pennis non homini datis.*"\*

"I do not see the difficulty," exclaimed Tom.

"The weight of our bodies is so great that we have not sufficient muscular strength to impart a blow to the air that shall be equal to it. Now are you satisfied?" said his father.

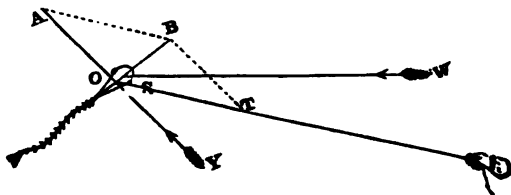
"I am perfectly satisfied, if that be the case, that we can never hope to fly."

"The principle, however, which I have just explained," observed Mr. Seymour, "although it will fail us in our attempts to construct wings, is nevertheless extensively appli-

\* "Artista," observes M. Oersted, "are greatly in attaching wings to human figures, of such a size, and so placed as to lead the imagination to accept them as real, instead of emblematic organs of flight. We are taught by comparative anatomy that in all vertebrate animals wings are only formed by a peculiar development of the instruments of motion belonging to the fore parts of the body; the representation of the human figure with wings and arms is therefore a monstrous absurdity; and the supernatural idea, by such an attempt to make it appear natural, is rendered unnatural."—*The Soul in Nature.*



cable in mechanics. A vane or fly, for instance, by resisting the air as it spins round, becomes the regulator of machinery. The intervals between the strokes on the bell of a clock are thus regulated, and the fly, on this occasion, is so contrived that this interval may be altered, or the clock made to strike faster or slower, by presenting the arms of it more or less obliquely to the direction in which they move. The same kind of fly is the regulator used in musical boxes, as I will presently show you, and indeed in almost all mechanical toys; and, moreover, a fly of this kind, provided its arms be set at a proper angle, and a rapid spinning motion be given to it, will actually take flight, and rise to a very considerable elevation, and thus realize the idea of a flying machine. I have such an apparatus, and intend to call it *The Flying Top*. On our return you shall see it—but at present we have to proceed with the subject of the kite; for, as yet, we have merely considered the effect of increasing the wind upon its surface: we have next to inquire how the wind operates in raising it into the air.—Do you not remember, when I adjusted the noose in the belly-band, I stated that much depended upon this part of the apparatus? You will at once perceive that it will influence the angle which the kite forms with the earth; and I am about to prove to you that the theory of the kite's ascent is materially connected with the value of this angle; but, in order to render my explanation intelligible, I have prepared a diagram, to which I am desirous of directing your attention.



"The kite here appears in the act of rising from the ground, the line w will represent the direction of the wind blowing

upon it, all the currents of which we will suppose united in one; it is evident, from what has been already stated, that as it falls upon an oblique surface, it will be resolved into two forces, viz., into one parallel with it, and into another perpendicular to that surface; of which the force represented by the line  $\gamma$  will alone produce any effect, carrying the kite along the line  $o \Delta$ , or in a direction parallel to itself; and you must have observed that this was the direction in which the kite was impelled, when you suffered it to rise, without checking its progress by the string."

"I remember that well," said Tom; "and I also observed that, when I pulled my string, the kite immediately rose more perpendicularly."

"To be sure it did; because by that operation, you called a new force into action; which I have represented in the diagram by the line  $s \tau$ . The kite was therefore under the influence of the two forces  $o \Delta$  and  $s \tau$ , and, since these are in the direction of the two sides of a parallelogram, it would not obey either, but ascend through  $o \Sigma$ , its diagonal."

"Notwithstanding Mr. Twaddleton's doubts upon the subject," said Tom, "I am sure that I perfectly understand your explanation; and I think I may also answer for my sister: but you have not yet told us any thing about the tail; I suppose, however, that it acts like the rudder of a ship, or the tail of a bird."

"Before I answer that question, let me inform you how the tail of a bird differs, in its action and uses, from the rudder of a ship. In the first place, the rudder is so fixed that it can but move in one horizontal plane, and can therefore only turn the vessel to the right or left, which, indeed, is all that is required (5); but the tail of the bird, in addition to this motion, can be placed in a diagonal direction, and when expanded will offer a considerable surface to the air, so as to fulfill some of the offices of a third wing. Have you never watched the maneuvers of the rook, as he gambols through the air? After flying in the ordinary way, you will observe his wings at rest, and that he glides along apparently without

the least exertion in his descent. In this case his expanded wings act as a parachute; then, again, you will observe him wheeling round, a maneuver which is partly produced by the oblique position of his tail, and which is readily explained upon the principle of the resolution of forces I have just described with reference to the action of the wind upon the surface of the kite (6). I ought also to state, that the tail serves to poise the body of the bird."

"Does the bird, then, never use its wings for the purpose of directing its course?" asked Louisa.

"Undoubtedly it does," answered her father; "the tail is only to be considered as a supplementary organ: it is by means of the wings that it generally directs its course, for it is evident that it can easily turn, either to the right or left, by flapping the opposite wing with increased force, just as a boat is turned about to the right, by a brisk application of the left oar. In like manner the irregular flight of the butterfly, now up and now down, now to the right and now to the left, is no doubt effected by the wings striking the air one after the other, or perhaps with an alternate and unequal force. The object of such an action is obviously to baffle the pursuit of birds which fly in a right line, whereas you see the butterfly does just the contrary." (7.)

"How very wonderful," said Louisa, "is the action of the wings of insects! I have often watched them during their flight, and their rapidity is such as to surpass the power of vision."

"I shall have occasion to advert to that subject hereafter," said Mr. Seymour; "at present I shall only observe that a gnat's wing, in its ordinary flight, beats many hundred times in a second."

"But you have not yet answered Tom's question," said the vicar. "Of what use is the tail of the kite? Does it assist its ascent, or is it merely an appendage of ornament?"

"In the first place, it keeps the head of the kite to the wind, and prevents its lower half from going too far to leeward; and in the next, it lowers its center of gravity, and

throws it towards its extremity, which not only prevents the chance of the machine being upset in the air, but it so poises and regulates the position of the kite as to maintain the angle which it is necessary for the string to make with the surface."

Mr. Twaddleton here inquired what might be the most advantageous angle for the kite to form with the horizon, in order that the paper machine should rise to the greatest altitude.

"If the wind be horizontal," answered Mr. Seymour, "it is evident that the inclination of the kite's surface ought to be the same as that which the rudder of a ship should make with the keel, in order that the vessel may be turned with the greatest facility; supposing the currents of water, which impel it, to have a direction parallel to the keel."

"And what ought that angle to be?" inquired the vicar.

"*Fifty-four degrees and forty-four minutes*," replied Mr. Seymour; "and let me here remark," continued he, "as we have already considered the philosophy of the flight of a bird, that its pinions are so set upon the body as to bring down the wings in an *oblique* direction towards the tail; so that in their action upon the air we have the same resolution of forces as in that of the wind upon the surface of the kite, by which the body of the bird is not only supported, or raised perpendicularly, but carried forward." (8.)

Tom here interrupted the dialogue, by expressing a regret that he should have been provided with so small a quantity of cord.

"I do not believe, my dear boy, that any advantage could be gained by an additional quantity of string," said his father.

"Is there, then, any reason why the kite should not ascend, even above the clouds, provided that my string were sufficiently long and strong?"

"Yes; indeed there is a most unanswerable reason. Remember that the kite is made to rise by the operation of two forces; the one afforded by the wind, the other by the action of the string; now, it is quite evident that, when the weight of the string, added to that of the kite itself, becomes equal to the force of the wind, acting upon the surface of the ma-

chine, a general balance, or equilibrium of forces will be established, and the kite can no longer continue to ascend."

"Will it, then, remain stationary under these circumstances?" asked Louisa.

"It must do so, unless the force of the wind should abate; for it is a proposition in mechanics, which I shall hereafter endeavor to demonstrate (9), that, if a body be acted upon by three forces, which are proportional to, and in the direction of the three sides of a triangle, it will be kept at rest. The kite is exactly in this predicament, for its weight, the force of the wind, and the action of the string fulfill these conditions, and consequently keep the kite stationary."

"Then I must give up my intention of trying to raise the kite above the clouds," said Tom.

"Although you may not be able to raise any single kite to the altitude you may desire, it is easy to accomplish your plan by a series of kites; the string of the first being attached to the back of the second, and so on."

"How, papa? I do not exactly understand you."

"Your kite," said Mr. Seymour, "is now as high in the air as the force of the wind is capable of raising it; suppose you were to fix the end of the string you hold in your hand to the back of another kite, would not this second kite ascend as high as your first, by the same force, and your first kite therefore rise to double the altitude it is at present? In like manner you might attach a third kite, and so on."

"Now I comprehend it; and I should much like to try the experiment," said Tom.

"You shall certainly witness the effect I have described; but you must provide yourself with some stout string, for the force which the kites exert when thus arranged, is greater than you can easily imagine; indeed I question whether you would be able to hold them," observed his father.

Mr. Twaddleton here informed the young party that he had himself witnessed a carriage containing three persons that had been drawn along the road by kites, at the rate of from fifteen to twenty miles an hour.





"I have seen the account of it," said Mr. Seymour, "and if I remember right, the principal kite was preceded at the distance of about 120 feet by a smaller pilot one, which served to direct it away from any obstacles, such as trees, houses, &c., with which it might otherwise have come in contact."

"But how was the pilot-kite made obedient to the will of the driver?" asked Louisa.

"By means of strings so attached to it that its surface was easily made to alter its angular position," answered Mr. Seymour.

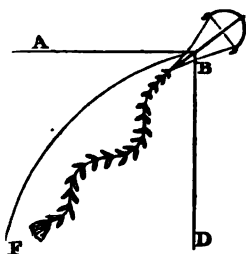
"If my twine should snap," said Tom, whose attention was suddenly drawn to his kite from a slight unsteadiness in its motion, arising from a gust of wind, "we could easily recover it, that is one good thing; for it is hovering over the open field at the end of the heath."

"If you imagine that the kite, under such circumstances, would fall upon the spot directly under it, you are much deceived: recollect that, if the string should snap, the kite would be abandoned to two forces, those of the wind and its own gravity; and you will perceive that, under such circumstances, it could not obey either of them, but would fall in an intermediate or diagonal direction. This fact will be rendered apparent by the annexed diagram.  $BA$  may be supposed to represent the force and direction of the wind acting upon the kite, and  $BD$  that of its gravity; then it is evident that, under the influence of these joint forces, it would describe the diagonal, and for reasons already explained, that line must necessarily be the *curve BF*."

"Come," said the vicar, "before Tom draws down his kite, let us send up a messenger."

"What may that be?" asked Louisa.

"A piece of paper or pasteboard, which, on being intro-





duced upon the string, is blown along the line up to the kite."

The *messenger* was accordingly prepared, and, being placed upon the string, it ascended as Mr. Seymour had anticipated. While this operation was in progress, the vicar stood earnestly gazing upon the kite, and, at length, burst forth in the following animated soliloquy:

"Assuredly this must be acknowledged as a most beautiful and imposing toy! Fastidious or insensible must be that person, who does not feel exhilarated as he gazes on the kite, proudly floating under the canopy of heaven, and reflecting the departing smiles of the evening sun, after it had ceased to cheer us below."

"It has been said," observed Mr. Seymour, "to the disparagement of kite-flying, that as soon as the machine has been raised into the air, and all the string let out, the excitement of the sport is at an end, and that, as nothing further can be achieved, the interest of the performer from that moment begins to languish; now, at this period, the *messenger* will open a new source of pleasure and instruction, and may, by a little ingenuity, be made to afford a great diversity of amusement. I have therefore provided myself with several varieties of this machine. Here is one in the form of a dragon, which, as it ascends, produces a very striking and almost magical effect. See, there it goes!"

The children were delighted, for the string upon which it was carried became at a certain height invisible; so that the figure appeared like a monster hovering in the air.

"I will now show you a *winged* variety of this apparatus, which we will name the *Brompton Messenger*.\* It consists of a hollow cylinder of thin wood, the diameter of which is sufficiently large to allow its free revolution round the string of the kite. To this cylinder are attached several flappers, or sails, in an oblique direction, like those of the '*Flying Top*'

\* From associations of an interesting nature connected with the residence of the author's children with kind and beloved friends for many a successive autumn.

(p. 259), each of which is covered with paper of a different color. The action of the wind upon those oblique surfaces necessarily occasions a rapid rotation, upon a principle which I shall presently explain; and the beautiful effect thus produced, as the whirling body ascends, must be seen before it can be appreciated. I have some other contrivances of a similar nature, which it is my intention to prepare for your future amusement." (10.)

"Has the kite ever been applied to any useful purpose?" asked Tom.

"Certainly," answered his father. "It was by means of the kite that Dr. Franklin was enabled to demonstrate the identity of electricity and the cause of lightning, and thus to disclose one of the most awful mysteries of nature."

"Pray do tell us something about this electrical kite, papa," said Louisa.

"Not at present, my love; it would divert us too much from the subjects in which we are engaged; at some future period I shall have much pleasure in introducing you into these fairy regions of philosophy."

"I just now remember reading in Miss Edgeworth's 'Harry and Lucy,' " said Louisa, "something about a kite and Pompey's pillar."

"I am glad that you have reminded me of that story," replied Mr. Seymour; "I will relate it to you. Some English sailors laid a wager that they would drink a bowl of punch on the summit of Pompey's pillar. Now, that pillar is almost a hundred feet high, and it is quite smooth, so that there was no way of climbing to the top, even for sailors, who are such experienced climbers: so they flew their kite exactly over the pillar, and when it came down on the opposite side, the string lay across the top of the capital. By means of this string, they pulled a small rope over, and by this a larger one, that was able to bear the weight of a man; a pulley was then fastened to the end of the large rope, and drawn close up to the upper edge of the capital; and then, you perceive, they could easily hoist each other up. They did more,

for they hoisted the English flag on the top, and then drank the bowl of punch and won their wager."

"That is a very good story," said the vicar, "but I cannot help regretting that so much ingenuity and labor should not have had a nobler end to accomplish."

"There is some truth in that observation," said Mr. Seymour, "and I will, therefore, relate another story which shall be more congenial to your heart, and in which the kite will present itself in a more interesting point of view, for, instead of enabling the sailors to drink a bowl of punch at any altitude otherwise inaccessible, we shall find it engaged in rescuing them from the horrors of shipwreck."\*

"Pray proceed, papa."

"No, my dear, upon reflection, I think it will be better that we should postpone the story, until you return to the lodge, when you shall read it in 'Harry and Lucy.' But before we lose sight of the useful applications of the kite, let me tell you how greatly it served the Arctic voyagers in their late search after Franklin and his companions. By harnessing it to their sledges they were enabled to travel hundreds of miles over the ice before a stiff breeze. I will also point out to you, in the same work, an account of a new and useful application of the messenger, which will prove that the faculties of youth may be increased and improved by those very amusements which are too generally regarded as idle and unprofitable: I shall at the same time exhibit one or two experiments in illustration of the nature and causes of wind."

"Shall we not return immediately?"

"No, my dear; it would not be in my power to attend you at present; but join me in the library after dinner: Mr. Twaddleton will now accompany me to the village, and do you remain and enjoy the amusement of your kite."

At the time appointed Tom and his sisters requested their father to fulfill the promises he had made them in the morning.

\* Transactions of the Society for the encouragement of Arts, vol. xli. and Miss Edgeworth's Harry and Lucy, vol. iv. p. 288.

"You told us," said Louisa, "that you would give us some information about the wind; the subject has been puzzling me ever since, for I cannot make out the cause of it."

"Wind, my love, is nothing more than air in motion; and is produced by a large volume of it flowing in a current or stream, from one place or region to another, and with different velocities."

"And what can produce these currents?" asked Tom.

"After the explanation of the action of the pump, I do not think that I shall have much difficulty in making you understand the nature of the operations by which wind is occasioned. Suppose a partial vacuum should be formed in any region, would not the neighboring air immediately rush in to supply the deficiency and restore the balance?"

"Undoubtedly; from the pressure of the air behind it."

"Heat," continued Mr. Seymour, "will produce a partial vacuum by rarefying the air, and thus rendering it lighter; in consequence of which it will ascend, and the colder air will rush in to supply its place."

"I do not exactly see why the rarefied air should ascend," observed Louisa: "it appears to offer an exception to the general law of gravity."

"Not at all; on the contrary its ascent is occasioned by the force of gravity: in the first place, however, to prove the fact that heated air does actually ascend, we have only to observe the direction of smoke as it issues from the chimney: this consists of minute particles of fuel carried up, by a current of heated air, from the fire below; and as soon as this current is cooled by mixing with that of the atmosphere, the minute particles of coal fall, and produce the small black flakes which render the air, and every thing in contact with it, so dirty in a populous city."

"But I want to know, papa, what it is which causes the hot air to ascend?"

"The greater weight of the cold air above it, which gets, as it were, beneath the lighter air, and obliges it to rise; just in the same way as a piece of cork, at the bottom of an

empty vessel, is made to rise to the surface of the water which may be poured into it."

"Now I understand it; pray, therefore, proceed with your account of the wind. You have just said that heat rarefies the air, and causes it to ascend."

"And thus produces a current of air, or a *wind*."

"Is heat, then, the cause of wind, papa?" asked Tom.

"It is one great cause; but there are, probably, several others; I will, however, exemplify this subject by an experiment."

So saying, Mr. Seymour produced a water-plate, a large dish, and a jug filled with cold water. The bell was rung, and the servant entered with a tea-kettle of boiling water. The large dish was then filled with the cold, and the water-plate with the boiling fluid.

"Let this large dish represent the ocean," said Mr. Seymour, "and this water-plate, which I will now place in its center, an island in that ocean; for the land, from receiving the rays of the sun, will be more heated than the water, and will consequently rarefy the air above it.—Now, Tom, light me the wax-taper."

"I have done so."

"Then blow it out."

"I cannot imagine what you are about, papa;—'Light the candle and then blow it out!'—but it still smokes; shall I put the extinguisher over it?"

"By no means; give it to me and observe what will happen when I carry it round the edge of the dish."

"Why, only see!" cried Tom; "Louisa has actually blown it in again.—How could that happen?"

"Do not interrupt our experiment just now, and I will explain it afterward. (11.) Now blow it out once more," said Mr. Seymour.

"I have done so, and the smoke goes to the center," exclaimed Tom.

"Showing, thereby, the existence of a current toward the water-plate, or island; in consequence of the air above it

having been heated, and therefore rarefied. This explains, in a very satisfactory manner, a fact which may be constantly observed in our own climate, viz., a gentle breeze blowing from the sea to the land in the heat of the day. Upon the same principle it is, that most of the winds in different parts of the globe may be readily accounted for."

"I suppose," said Tom, "that the air must rush with great velocity, in order to produce wind."

"A very general error prevails upon this subject; the rate of motion has been greatly exaggerated. In a brisk gale, even, the wind does not travel with such velocity but that it may be easily traced by the eye; and the sailor is able to watch its progress by the ripple which it produces on the sea."

"Has, then, the rate of its motion ever been estimated?" asked Louisa.

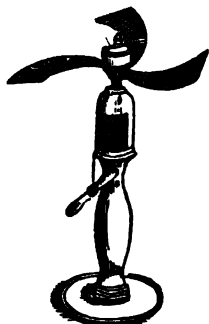
"When its velocity is about two miles per hour, it is only just perceptible. In a high wind, the air travels thirty or forty miles in the same period. In a storm, its rate has been computed as being from sixty to eighty miles. It has also been ascertained by experiment that the air, as it rushes from a pair of blacksmith's bellows, has not a velocity above that of five-and-forty miles in the hour."

"At what rate should you think the air traveled this morning, when we flew our kite?" inquired Louisa.

"I should think at about five miles an hour, for it was a pleasant but gentle breeze."

Mr. Seymour now, at the earnest request of the whole party, who had been on the tiptoe of expectation, produced his "FLYING-TOP," of which the reader is here presented with a representation.

"This little machine consists, as you may observe, of a flyer, with three vanes, the form of each being that of the seg-



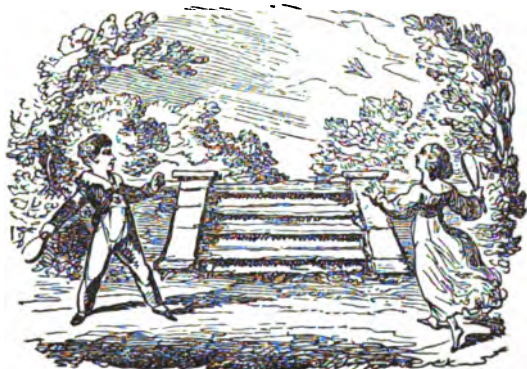
ment of a circle, the obliquity of whose surface increases as it recedes from the center of motion; this flyer, as you see, is attached to a spindle, around which the string that is to set it in motion is carefully wound, and the whole is adapted to a stand. Let us now join the vicar on the lawn, where we can conveniently put it into action."

The stump of a tree afforded a rest for the stand, which Mr. Seymour held firmly in an inclined position with his left hand, while with his right he vigorously pulled the string. Away whirled the flyer, and in a second it rose majestically from the stand, and, whizzing through the air, attained a very considerable altitude, no less to the astonishment than to the delight of the party. After several repetitions of the experiment, Mr. Seymour thus proceeded to explain the philosophy of its flight.

"After the explanation you have already received regarding the flight of a bird, you will very readily understand the question before us. It is evident that the oblique vanes, by striking the air during their rapid rotation, must produce a reaction on their under surfaces."

"Exactly so," cried Tom; "and if that reaction be greater than is sufficient to counteract its gravity, the flyer must ascend in the air, just as the bird does, in proportion to that excess."

"You are quite right," continued his father, "and I need hardly remind you of the importance of attending to the angular adjustment of the vanes to insure the greatest effect; it should be such as to make all the forces conspire, and you will recollect that the efficient force will be in a direction perpendicular to each inclined vane."



## CHAPTER IX.

A SHORT DISCOURSE.—THE SHUTTLECOCK.—ITS CONSTRUCTION.—THE SOLUTION OF TWO PROBLEMS CONNECTED WITH ITS FLIGHT.—THE WINDMILL.—THE SMOKEJACK.—A TOY CONSTRUCTED ON THE SAME PRINCIPLE.—THE BOW AND ARROW.—ARCHERY.—THE ARRIVAL OF ISABELLA VILLERS.

MR. TWADDLETON, on his arrival at the Lodge on the following morning, was informed that Miss Villers was expected at Overton in the evening.

"Your account of that young lady," observed the vicar, "has greatly prepossessed me in her favor; I only hope that she is not too *blue*."

"I care not how blue the stockings of a lady may be," said Mr. Seymour, "'provided her petticoats be long enough to hide them; and from my knowledge of Miss Villers, I can assure you, exalted as are her attainments, they are so veiled by feminine delicacy and reserve, that they may insidiously win, but will never extort our homage.'"



"Ay, ay," exclaimed the vicar; "I perfectly agree with you in your idea of feminine perfection—short tongues and long petticoats, Mr. Seymour. But where are my little play-mates?"

"I left Tom and Fanny on the terrace, a short time since, very busily engaged in the game of shuttlecock and battledoor."<sup>\*</sup>

"The shuttlecock is an ancient sport," observed Mr. Twadleton. "It is represented in a manuscript as far back as the fourteenth century: and it became a fashionable game among grown persons in the reign of James the First. In China the shuttlecock is made of feathers and lead, and is played by being struck up by the soles of the feet. A toy of this kind may be seen in the Ethnological room in the British Museum."

"It is a very healthy pastime," said Mr. Seymour, "and, in my opinion, is admirably calculated for females; for it expands the chest, while it creates a graceful pliancy of the limbs."

"I entirely agree with you; it is the only game with which I am acquainted, in which muscular exercise is gained without compromising gracefulness. But see, here come the two young rogues."

"Papa," exclaimed Tom, "I have been considering whether there is any philosophy in the game of shuttlecock."

"There are two circumstances connected with its flight, which certainly will admit of explanation upon scientific principles; and I should much like to hear whether you can apply them for that purpose. The first is its spinning motion in the air; the second, the regularity with which its base of cork always presents itself to the battledoor; so that, after you have struck it, it turns round, and arrives at your sis-

<sup>\*</sup> SHUTTLECOCK, more correctly, perhaps, *Shuttlecock*, although Skinner thinks it is called *cock* from its feathers. *Battledoor*, so called from *Door*, taken for a flat board; and battle for striking, *i. e.*, a striking-board. Thomson thinks that the true derivation is from the Spanish *Batidor*, a beater or striker, and that the game was introduced from the Peninsula.

ter's battledoor in a position to be again struck by her, and sent back to you."

"I perfectly understand what you mean; but I really am not able to explain the motions to which you allude," said Tom.

"The revolution of the shuttlecock, about its axis, entirely depends upon the impulse of the wind on the oblique surfaces of its feathers; so that it is often necessary to trim the feathers of a new shuttlecock, before it will spin."

"I understand you, papa; the force of the wind, by striking the oblique feathers, is resolved into a perpendicular and parallel force, as you explained to us when we considered the action of the wind upon the kite."

"Exactly; every oblique direction of a motion is the diagonal of a parallelogram, whose perpendicular and parallel directions are the two sides. Having settled this point, let us consider the second, viz., how it happens that the cork of the shuttlecock always presents itself to the battledoor."

"I should think," said Tom, "that the cork points to the battledoor for the same reason that the weathercock always points to the wind."

"Admirably illustrated!" exclaimed his father; "the cork will always go foremost, because the air must exert a greater force over the lighter feathers, and therefore retard their progress; but I must also direct your attention to the shape of the cork, which you may perceive to be *conical*, giving to the shuttlecock a readier passage through the air. Now this fact has an especial interest at the present time, from recent experiments showing the superior advantage of conical bullets in rifles; but we will talk to the major about it. While we are upon this subject, I will introduce to your notice some contrivances which are indebted to this same principle for their operation. In the first place, there is the arrow; can you tell me, Louisa, the use of the feathers which are placed round its extremity?"

"To make its head proceed foremost in the air, by rendering its other end lighter, and therefore more sensible to the resistance of the air."

"Very well answered: that is, unquestionably, one of the objects of the wings of an arrow; but there is also another, that of *rifling* it, or steadying its progressive motion, by causing it to revolve around its axis. If you will look at this arrow, you will perceive that the feathers are placed nearly, but not quite, in planes passing through it: if the feathers were exactly in this plane, the air could not strike against their surfaces when the arrow is in motion: but since they are not perfectly straight, but always a little aslant, the air necessarily strikes them as the arrow moves forward; by which force the feathers are turned round, and with them the arrow or reed; so that a motion is generated about its axis; and its velocity will increase with the obliquity of the feathers. You will therefore observe that, in order to enable the feathers to offer a necessary resistance to the air, they must possess a certain degree of stiffness or inflexibility. It was on this account that Roger Ascham,\* and other skillful artists in the days of archery, preferred the feathers of a goose of two or three years old, especially such as drop of themselves, for pluming the arrow; and the importance, as well as the theory of this choice, is confirmed by a curious observation of Ger-vase Markham,† who says that 'the peacock feather was sometimes used at the short butt; yet seldom or ever, *did it keep the shaft either right or level!*'"

"That is intelligible enough," said Tom; "the feather of the peacock must have been so flexible as to have yielded to the slightest breath of air; and now, as we are upon the subject of the arrow, do explain to us the action of the bow."

"I shall readily comply with your request before we part; but I am desirous, at present, of following up the subject before us, and of taking into consideration some other instruments which owe their motions to the action of the air upon oblique surfaces."

"Suppose," said the vicar, "you explain to them the action of the wind upon the sails of the mill."

\* Toxoph. ed. 1571, folio 166.

† Markham's Art of Archery, 1684.

"I should like to hear something about the windmill," observed Tom: "and perhaps Mr. Twaddleton can tell us who invented the machine."

"The invention is not of very remote date. According to some authors, windmills were first used in France in the sixth century; while others maintain that they were brought to Europe in the time of the crusades, and that they had long been employed in the East, where the scarcity of water precluded the application of that powerful agent to machinery."

"I had intended," said Mr. Seymour, "to have entered very fully upon the subject of the windmill; for although it is a very common machine, its construction is much more ingenious than is generally imagined; it must also be allowed to have a degree of perfection, to which few of the popular engines have yet arrived; but to do ample justice to my subject, I should require several models which are not yet in readiness; besides, Tom's holidays have nearly passed away: I must therefore postpone the examination of the mill to some future opportunity, and content myself, at present, with an explanation of its sails."

"And let me tell you," observed the vicar, "that if you succeed in this one object, you will accomplish a task which has occupied years of mechanical research. The angle which the surface of the sails ought to make with their axis, in order that the wind may have the greatest effect, or the degree of *weathering*, as the millwrights call it, is a matter of nice inquiry, and has much engaged the thoughts of the mathematicians."

"My remarks upon that subject will be very general," said Mr. Seymour; "I shall explain the principle, without entering into the minutiae of its applications. The vertical wind-mill, which is the kind in most common use, consists, as you well know, of an axis, or shaft, placed in the direction of the wind, and usually inclining a little upward from the horizontal line. At one end of this, four long arms, or yards, are fixed perpendicular to the axis, and across each other at right angles; these afford a surface, on which a cloth can be spread

to receive the action of the wind. To conceive why these sails should revolve by the force of the wind, we must have recourse to the theory of compound motion. It is very evident that, if a mill exposed directly to the wind should have its four sails perpendicular to the common axis in which they are fitted, they would receive the wind perpendicularly, an impulse which could only tend to overturn them; there is a necessity, therefore, to have them oblique to the common axis, that they may receive the wind obliquely, when their effort to recede from it causes them to turn round with the axis; and the four sails, being all made oblique in the same direction, thus unite their efforts for the common object."

"You have not yet told us what degree of obliquity the sail ought to make with the wind," said the vicar.

"The same as the kite ought to make, *fifty-four* degrees and *forty-four* minutes."

"Do you not remember, papa, when we were last in London, you pointed out to us a curious mill on the banks of the river, which went without any sails?"

"You allude to the horizontal mill at Battersea."

"I remember it was at Battersea," observed Louisa; "and I dare say, papa, that you recollect the strange story which the waterman, who rowed us down the river, told Tom and myself. He said that, 'when the Emperor of Russia was in London, he took a fancy to the neat little church at Battersea, and determined to carry it off to Russia; and that for this purpose he had sent a large packing-case; but, as the inhabitants refused to let the church be carried away, the case remained on the spot where it was deposited.'"

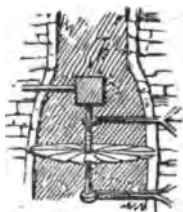
"It is not a bad story," said her father, "for the mill certainly, both in size and figure, may be imagined to resemble a gigantic packing-case. The mill, of which you are speaking, has been taken down, in consequence of its use having been superseded by the introduction of steam. It was erected by Captain Hooper, who also built a similar one at Margate. It consisted of a circular wheel, having large boards or

vanes fixed parallel to its axis, and arranged at equal distances from each other. Upon these vanes the wind could act, so as to blow the wheel round; but had it acted upon the vane at both sides of the wheel at once, it is evident that it could not have had any tendency to turn it round; hence, one side of the wheel was sheltered, while the other was submitted to the full action of the wind. For this purpose it was inclosed within a large cylindrical framework, furnished with doors or shutters, on all sides, to open at pleasure and admit the wind, or to shut and stop it. If all the shutters on one side were open, while all those on the opposite side were closed, the wind, acting with undiminished force on the vanes at one side, while the opposite vanes were under shelter, turned the mill round; but whenever the wind changed, the disposition of the blinds was altered, to admit the wind to strike upon the vanes of the wheel in the direction of a tangent to the circle in which they moved."

"Well; have you any other machine to explain to your scholars?" asked the vicar; "for I am anxious to present them with a bow and arrow which I have provided for their amusement."

"I will, if you please, first describe to them the mechanism of the smoke-jack; and I am desirous of doing so, as I have a very pleasing experiment to exhibit, which is founded upon the same principle."

Mr. Seymour then described the more common form of this machine. It consisted, he said, of a number of vanes, of thin sheet-iron, arranged in a circle, as here represented, but all set obliquely at a proper angle of inclination. Its action was explained in the following manner: When a fire is kindled in the chimney, the air, which, by its rarefaction, immediately tends to ascend, strikes on the surfaces of the inclined vanes, and by a resolution of forces, similar to that already explained, causes the spindle, to which they are



affixed, to turn round, and consequently communicates the same motion to the spit. The brisker the fire becomes, the quicker will the machine move, because in that case the air ascends with greater rapidity.

"I will now exhibit to you a mechanical amusement which is founded on the same principle. Fetch me the piece of pasteboard which lies on the library table."

The pasteboard was produced, and Mr. Seymour described upon it a spiral, similar to that which is represented in the annexed figure. The spiral was cut out, and extended, by raising the center above the first revolution. It was then suspended upon a small spit of iron, which had been previously prepared, by applying the center or summit of its spiral to its point. The whole was now placed on the top of a warm stove (the application of a lamp would have answered the same purpose), and the machine, to the great delight and astonishment of the children, soon put itself in motion, and turned without the assistance of any apparent agent. The agent, however, in this case, was the air, which, being rarefied by the contact of a warm body, ascended, and thus produced a current. The accompanying sketch may render this experiment more intelligible to the reader.



The vicar observed, that, to him, "the experiment was perfectly novel; although he remembered having seen what he now supposed must have been a similar contrivance, but which, until that moment, he had always considered as the effect of clock-work."

"And what might that have been?" asked Mr. Seymour.

"The revolution of a serpent, which I noticed in several windows in London, during a late illumination."

"Undoubtedly; it was nothing more than a spiral, so painted as to resemble that reptile, and which owed its motion to the action of air heated by a lamp placed beneath it."

"Now, then," exclaimed the vicar, "let us direct our attention to the bow and arrow; see the present I have provided for you, Tom!"

So saying, the worthy clergyman produced a bow and a number of arrows, together with a target; which, at his desire, had been sent from London.

"I think," observed Mr. Seymour, "that you should accompany your gift with some account of archery, or the art and exercise of shooting with the bow and arrow."

"That will I readily do," replied Mr. Twaddleton; who accordingly proceeded as follows:

"The bow is the most ancient and universal of all weapons, and has been found to obtain among the most barbarous and remote nations. In the days of David the practice of the bow would appear to have been so general, that it was not unfrequently made use of as a figure of speech. Israel, when blessing his sons, says of Joseph, 'The *archers* have sorely grieved him, and shot at him, and hated him; but his *bow* abode in strength, and the arms of his hands were made strong, by the hands of the mighty God of Jacob.'"

"Its earliest application was probably for the purpose of obtaining food," observed Mr. Seymour.

"Your conjecture has the weight of testimony," replied the vicar; "when Isaac sent Esau to the forest, he said, 'Take, I pray thee, thy weapons, thy quiver, and thy bow, and go out to the field, and take me some venison:†' and it is even a question, whether the *Saxon* bow was ever used by the Anglo-Saxons and Danes for any other purpose than that of procuring food, or pastime; for the representation of this bow, in an ancient manuscript of the tenth century, shows it to have been very differently constructed from what one might expect in a military weapon; in size, too, it was a mere toy, compared with the bow of succeeding ages."

"There can be no doubt that the bow and arrow was employed for the purpose of killing animals for food from the earliest times; but its principal interest is derived from its

\* Gen. xlix. 23, 24.

† MS. Cott. Claud. B. IV.



military applications: will you, therefore, give us a sketch of its history, and confine yourself to its practice as a warlike instrument in England?"

"And may I also beg of you, my dear sir," added Mrs. Seymour, "to explain the different terms which are employed to denote its parts and applications? Such information will be, just now, highly acceptable to me, as I am reading some romances, in which those terms are constantly occurring."

"You shall be obeyed, madam," replied the vicar, with a courteous smile.

"We are, probably, indebted to the Norman conquest for the introduction of the bow and arrow as a hostile weapon; but, before I enter upon that subject, it is necessary to state, that the bows in use in England have been of two kinds, the common or *long* bow, and the *cross* bow. The former does not require any description from me; the latter, or *Arbalet*, as it was called (from *Arbalesta*, i. e., *arcu-balista*, a bow with a sling), consists of a steel bow, fastened upon a stock, and is discharged by means of a catch, or *trigger*, which probably gave rise to the look upon the modern musket."

"Excuse the interruption," said Mrs. Seymour; "but do allow me to ask whether *Arquebusade* does not derive its name from its having been formerly applied to wounds inflicted by the cross-bow or *Arbalet*?"

"I thank you, madam; that etymology is entirely new to me, and will explain the medical name *Aqua vulneraria*, which has been applied to that spirit."

The vicar now proceeded without further interruption.

"The invention of cross-bows is said by ancient writers to have come from the Sicilians. They were first used in England by the Normans at the battle of Hastings; and a *quarrel* or *bar-bolt* (which is synonymous with the arrow of the long-bow) was the immediate cause of Harold's death. In the reign of Stephen, in 1139, the second council of Lateran prohibited their use; and some historians assert, that they were not again used in this country till the reign of Richard I.,

whose death, occasioned by one at Chalus, was considered as a judgment on his impiety. From the death of Richard till the splendid victories of Edward III., we hear little of the cross-bow as a military weapon. Its use appears to have been principally confined to the sieges of fortified places, and to sea-fights. In 1346, at the battle of Cressy, a large body of Genoese soldiers, who were particularly expert in its management, were in the service of the French; but at the commencement of the action, a sudden shower wetted the strings and prevented the archers from doing their usual execution, while the English were still capable of annoying their enemies by the long bow with complete success; both this victory and that of Poitiers, ten years afterward, were chiefly ascribed by the English to their archers. In 1403, at the battle of Shrewsbury, where Hotspur was slain, the archers on both sides did terrible execution; and the victory of Agincourt, in 1415, was entirely owing to their skill. Under Edward IV. an ordinance was made, that every Englishman and Irishman, dwelling in England, should have a bow of his own height, to be made of yew, wych, hazel, ash, or any other seasonable tree, according to their power. By Henry VII. and his son Henry VIII. the use of the cross-bow was entirely forbidden; and a penalty of ten pounds was to be inflicted on every man in whose house one might be found. From this time they seem to have been chiefly used for killing deer.\* Henry VIII. compelled every father to provide a long-bow and two arrows for his son at seven years old. Edward VI., Elizabeth, and James, all encouraged archery; John Lyon, who founded Harrow school in 1590, two years before his death, drew up rules for its direction, whereby the amusements of the scholars were confined to 'driving a top, tossing a hand-ball, running, and shooting.' The last-mentioned diversion is in a manner insisted on by the founder, who requires all parents to furnish their children with bow-string, shafts, and tresters, to exercise shooting. A silver

\* See Shakespeare's Henry VI.

arrow used some years ago to be shot for by the young gentlemen of that school."

The vicar concluded, and received the thanks of the party for the interesting information he had afforded them.

"There is one circumstance connected with the military history of the long-bow," said Mrs. Seymour, "which has somewhat surprised me; and that is, why it should so long have continued in estimation after the use of gunpowder."

"That circumstance," replied her husband, "will cease to astonish you, when you remember that, until the last century, muskets were very unwieldy instruments; they were never used without a rest, had no bayonets, and could not be so frequently discharged as they are at present."

"Come," said the vicar, "I perceive that the children are impatient to try their skill with their new instrument; let us walk out, and I will play the Scythian upon this occasion."

"Now, Tom," cried Mr. Twaddleton, "we must have an object. Let me see. Shall it be the '*but*,' '*pricke*,' or '*roarer*?' Come, try whether you can hit yonder gate-post. Take your bow, and here is an arrow."

Tom took the bow, and, placing the arrow on the string, was about to draw the latter, when the vicar exclaimed, "Stop—stop; you must pull back your hand to your right ear, in order to shoot the arrow; whereas you have placed the bow directly before you, and are about to return your hand to the right breast."

"I thought," said Tom, "that was the proper position; for I remember reading of the Amazonian women, who are said to have parted with their right breasts, lest they should prove an impediment to their using the bow."

## CHAPTER X.

ORIGIN OF THE CRESCENT AS THE TURKISH ENSIGN.—APPARITIONS DISPELLED, AND MYSTERIES SOLVED BY PHILOSOPHY.—FAIRY-RINGS.—MUSICAL INSTRUMENTS CLASSED UNDER THREE DIVISIONS.—MIXED INSTRUMENTS.—THEORY OF WIND INSTRUMENTS.—THE JEW'S-HARP.—THE STATUE OF MEMNON.—AN INTERESTING EXPERIMENT.—THE FLUTE.—THE WHIZ-GIG, ETC.—ECHOES.—THE MYTH OF NARCISSUS.

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ON entering the library on the following morning, Mr. Seymour informed Miss Villers that Major Snapwell had taken his departure in order to breakfast with the vicar, and that he had invited Tom and Louisa to accompany him, for the sake of inspecting the cabinet of medals; but he added that he expected the return of the party at two o'clock, when he proposed to give them a lecture upon the philosophy of the several toys which are indebted for their action to atmospheric vibrations.

"Suppose, then," said Miss Villers, "that we walk toward Forest Lane, and meet them on their return. This arrangement," she added, "will afford me an opportunity of communicating to you the history of some adventures I encountered last evening, and of taking your opinion upon them."

"You well know," answered Mr. Seymour, "that you may always command my services. But you have really raised my curiosity: what can be the nature of the adventures you speak of?"

Miss Villers then entered into a particular account of all she saw and heard the preceding evening; with which the reader is already acquainted. Mr. Seymour, however, suggested the propriety of abstaining from any discussion upon the subject until the children were present to hear it; for,

said he, "I am most desirous that they should be familiarized with those natural sources of illusion which enlighten the wise, while they minister to the superstitious fears of the ignorant."

They had not reached the entrance of Forest Lane, before they perceived the vicar with Tom and Louisa, followed by the major.

"Papa," cried Tom, as he ran to meet his father, "we have had a most delightful morning; among other things, do you know we have found out the meaning of the crescent, which the Turks always wear and use as their ensign?"

"Indeed! well, then, let me hear your explanation," said his father.

Major Snapwell and the vicar had by this time joined the party, and with their assistance Tom was enabled to offer the following account of it. The crescent appears on the early coins of Byzantium, and was intended to commemorate the defeat of Philip of Macedon, who, as he was about to storm it on a cloudy night, was discovered by the sudden light of the moon. When the Turks entered Constantinople, they found this ancient badge in various parts of the city, and, suspecting that it might possess some magical power, they assumed the symbol and its power to themselves; so that the crescent became, and still continues to be, the chief Turkish ensign.

"Well, I must own that you have given me a new and very curious piece of historical information, and I thank you for it," said Mr. Seymour.

"Medals, then, are occasionally of some little use," remarked the vicar, with a sarcastic smile; for, if the truth must be told, the reverend antiquary had been a little nettled as usual by the freedom with which Major Snapwell had criticised some of his rarities: but let that pass.

As soon as the party reassembled after the excursion of the morning, the circumstances which so greatly astonished Miss Villers on the preceding evening were again related by her.

"My dear young lady," observed Mr. Seymour, "I never heard a better story for illustrating the illusions to which the senses are exposed; and if you will read the second letter on 'Natural Magic,' by Sir David Brewster, you will obtain a ready explanation of your vision: but let us examine it philosophically. In the first place, you acknowledge that your imagination had been previously excited during your ramble through the wood, and more especially by your reverie at the statue of Time; now it is well known that such a condition of the mind prepares and adapts the organs of vision for those illusions which I am about to explain. You have told us that, on your descent into the valley, the moon had withdrawn its light, and several minutes had elapsed before an object became visible, and that was the *white* foam of the waterfall."

"If I rightly remember, Brewster has stated that the specters that are conjured up by the imagination are always *white*, because no color can be seen at night," observed Mrs. Seymour.

"Undoubtedly," replied her husband; "and as these specters are formed out of objects whose different parts reflect different degrees of light, their fainter parts will appear and disappear with the ever-varying degree of illumination which is occasioned by the moon shining through a veil of clouds, and a change even of shape will be thus produced which will impart to the object in question the semblance of a living form. The actual state of the eye itself will also greatly assist in completing such an illusion; for, in consequence of the small degree of light, the pupil expands to nearly the whole width of the iris, in order to collect every ray, and in such a condition it cannot accommodate itself to see near objects distinctly; so that the form of a body actually becomes more shadowy and confused when it comes within the very distance at which we count upon obtaining the best view of it."

"You have certainly explained the reason why bodies seen under a faint illumination may appear distorted and caricatured; indeed, I now remember that Sir Walter Scott, in his

'Pirate,' has given us a very good illustration: for Cleveland, when abandoned on Coffin-bay, is said to have seen many a dim and undefined specter in the misty dawn. But I am still at a loss to understand how the vision I witnessed in the valley could have been conjured up," said Miss Villers.

"It was the doubtful and flickering light of the clouded moon upon the mass of white sandstone, or, in the words of Milton, that of 'a sable cloud that turned forth her silver lining on the night,'" said Mr. Seymour. "It is a great law of the imagination, that *a likeness in part tends to become a likeness of the whole*. The sandstone presented, in the first instance, a form somewhat resembling the human figure, or some part of it, when your active imagination immediately completed the outline; just in the same way as we trace images in the fire, or castles in the clouds, or grotesque figures of men and animals on damp walls." (14.)

"I am satisfied," said Miss Villers, "and I thank you, and Sir David Brewster, for the lecture; and now," continued the lady, "how will you explain the circumstance of my name having been so audibly pronounced, and from a spot which made it impossible that it should have come from any human being?"

"It was the solitary spirit of the dell," said Mr. Seymour, with a smile; "a rural spirit who is disposed to become very loquacious whenever the repose of her habitation is disturbed. I can assure you," added he, "that you are not the first person whom her gambols have surprised and terrified in the shades of evening. I presume you have discovered that I allude to that unseen musician of the air—Echo."

"Indeed, Mr. Seymour, the sound could not have been the effect of an echo, for I never spoke," replied Miss Villers.

"Very likely, but I happen to know that Mrs. Seymour called you by name at the orchard gate."

"Nor will that explain it," observed Miss Villers; "for in that case I must certainly have heard her; whereas the sound came in a very different direction, from the inaccessible rocks of sandstone."







"Young lady," said Mr. Seymour, "you must forgive me for telling you that your philosophy is at fault. It is as possible to hear an echo without recognizing the direct sound which produced it, as it is for two persons to be so placed as to see each other in a looking-glass, although objects might obstruct the direct view of themselves.\* Did you never walk between an irregular wall and a row of houses, or along a valley intercepted by houses, during the ringing of a peal of bells? Nothing is more common, under such circumstances, than for the sound, instead of arriving at the ear in its true direction, to be reflected in one that is opposite to it. Now before we quit the subject of optical illusion, let me relate an incident which occurred to myself. I presume you are all acquainted with the appearance in the grass, called a *Fairy-ring*?"

"To be sure," said Tom, "a very dark circle of grass, around which there is generally a ring that looks as if the ground had been burnt."

"Very well,—and we are now satisfied that this appearance is the consequence of the growth and decay of certain fungi, although the common people still believe that the ring is produced by the gambols of fairies. Now then for my story. It was on a moonlight night last August, when strolling along a neighboring meadow, enjoying the beauties of the evening, that I met a young farmer, an intelligent person, although a little inclined to a belief in the marvelous, who, on approaching with a hasty step, thus accosted me:—'You have often ridiculed my belief in fairies, and of their being the cause of those rings which go by their name; you may now, if you please, satisfy yourself of their reality, if you will only return with me to the elm-close, which, as you know, abounds with fairy-rings. Within the last few minutes I have actually seen them at their gambols under the great elm; they are, sir, tiny beings, which, as far as I could judge at a distance, cannot be more than a few inches in height; but there they are, frisking away most merrily to tinkling music. Pray, sir, do

\* See page 317.

let us return, and satisfy yourself as well as me.'—You may readily suppose that I lost no time in complying with my friend's request; and sure enough there they were."

"What, the fairies!" exclaimed Louisa, in astonishment.

"Have patience, my dear, and you shall hear. I confess," continued Mr. Seymour, "that, at the first glance, I was almost startled into a belief in the reality of my friend's assertion; but, on approaching, the Fairy Queen and her court were changed into a circle of fungi, to which the shadowy play of the leaves of the neighboring tree had, in the light of the moon, given the appearance of a fantastic motion, while their waving and rustling sounds mimicked wild music. The illusion, I will admit, was well calculated to impose upon the credulous countryman."

"So, then!" exclaimed the vicar, whimsically quoting the words of Falstaff, "'these were not fairies. I was three or four times in the thought they were not fairies.'"<sup>\*</sup>

The young party were much amused by this anecdote, and the vicar took the opportunity to explain, on natural principles, several superstitious appearances recorded in ancient legends.

Mr. Seymour now proposed to dedicate an hour to the explanation of the several toys which owe their action to atmospheric vibration; "I shall then," said he, addressing Miss Villers, "be at your service to interrogate the spirit of the valley; and the children, whom I intend to accompany us, will be thus better prepared to comprehend the theory of the echo."

"Musical instruments, among which I include the toys to which I have alluded, may be classed under three heads:—*stringed* instruments, such as the harp, violin, &c.; *wind* instruments, as the flute and trumpet; and instruments of *percussion*, as the tabor and drum."

"And which kind do you consider the most ancient?" asked Miss Villers.

"*Wind* instruments, madam, most unquestionably," cried

<sup>\*</sup> *Merry Wives of Windsor.*

Mr. Twaddleton. "Diodorus ascribed their invention to the accidental notice of the whistling of the wind in the reeds on the banks of the Nile; and the poet Lucrotius maintained a similar opinion."

"I really, my dear sir, cannot see any good reason for giving this preference, in point of antiquity, to wind instruments," said Mr. Seymour. "The lyre, or harp, is, surely, as ancient as any instrument on record. The mythologist ascribes the idea of producing sound by the vibration of a string to Apollo; which is said by Censorinus to have suggested itself to him, on his hearing the twang of the bow of his sister Diana. With respect to instruments of percussion, it may be reasonably supposed that the sonorous ringing of hollow bodies, when struck, must have very soon suggested their invention to mankind; but I really consider any research into a question of such obscurity as uninteresting as it must be hopeless; let us rather devote our attention to the philosophy of these instruments. I have stated that they may be referred to three principal classes; but I must at the same time observe that, in some cases, the vibrations of solid bodies are made to co-operate with those of a given portion of air; for example, trumpets and various horns may be said to be mixed wind instruments, since their sound is produced by the joint vibrations of the air and a solid body; and in certain stringed instruments, as in the violin, the immediate effect of the strings is increased by means of a sounding-board, which appears to be agitated by their motion, and to act more powerfully on the air than the strings could have done alone."

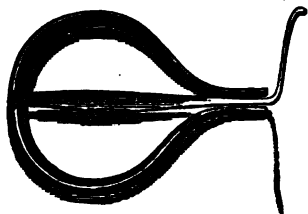
"I apprehend that this mixture must obtain more or less in all instruments," said the vicar.

"Not at all. The flute, flageolet, humming-top, and the cavity of the mouth in whistling, may be considered as simple wind instruments, in which the quality of the sound is alone determined by the vibrations of the air. I have already explained the manner in which the oscillations of a string excite aerial undulations, and thus produce sound; and you have seen that the nature of these sounds is determined by

the length and thickness of such strings : the theory equally applies to wind instruments, in which case a column of air corresponds with the string, the volume and length of which determine the sound. In the harp, the strings are constructed of different lengths and dimensions ; and so, in the *Syrinx*, or *Pan's pipes*, is the volume of air adjusted to the respective notes by the size and length of the reeds ; but, in the violin, the lengths of the strings are altered at pleasure by pressing them down on the finger-board ; and, in like manner, the effective length of the flute is changed by the opening or shutting the holes made at proper distances in them ; the opening of a hole at any part being the same in effect as if the pipe were cut off a little beyond it."

Mr. Seymour and the vicar then entered into a long discussion, with which it is not our intention to swell our history, or to exhaust the patience of the reader ; we shall, however, with his permission, collect from the mass some of the more interesting facts, and present them in as condensed a form as may be consistent with perspicuity. In speaking of the *Jew's-harp*, a little instrument with which every school-boy is well acquainted, the vicar stated that its origin was lost in the long lapse of time ; but that it was in very common use throughout Europe, and more especially in the Netherlands and the Tyrol, where it was the delight of the peasants and their families. He also said that it was known in Asia, and that the Greeks of Smyrna called it, in imitation of its sound, *biambo*. The name by which it is now known, he observed, was evidently derived from the Jews, who were formerly the great venders of it, and of other toys throughout Europe, although he stated that his friend Mr. Prybabel was of opinion that it was a corruption of *jaw's* harp. Mr. Seymour described its construction, and the theory of its action. It is composed of two parts, the *body* and the *tongue* : the former has some resemblance to the handle of a certain kind of corkscrew ; the latter consists of a little strip of steel, joined to the upper part of the body, and bent at its extremity, so that the fingers may touch it more readily. This tongue,

or elastic plate, produces in itself, only a sound which serves as a drone, although it appears to act like the motion of the bow of a violin in exciting other sounds, by breaking the current of air from the mouth, the acuteness or gravity of which will be determined by the pressure of the lips, and the



magnitude of the cavity of the mouth. To understand, however, this part of its operation, it is necessary that the reader should become acquainted with the nature and effects of what have been termed *Resonances*, and *Reciprocated Vibrations of Columns of Air*. This property of sounding bodies, which to the ignorant must appear as an inexplicable species of sympathy, will be more fully explained in a note (15); at present we shall merely give one or two examples of its effects. A singer has been known to break into pieces a large tumbler-glass by the power of his voice; and a violin suspended against a wall may be heard to yield the same notes as those produced by a performer on a similar instrument in the same room. To produce such an effect, however, one condition is indispensable, that the body to be put in vibration must be in unison, or agreeing in pitch, with the one communicating the sound. Hence the necessity of so adapting the capacity of the mouth, in playing the Jew's-harp, as to make the column of air which it contains to reciprocate the sound of its tongue. The subject was agreeably concluded by some anecdotes which were related by Miss Villers, in proof of the astonishing powers of this little instrument when directed by the skill of a master. For the sake of those who may be curious upon this subject, we have introduced an account of two great performers, in an additional note (16). In speaking of the flute, Mr. Twaddleton took occasion to observe that its name was derived from *fluta*,\* a lamprey, or

\* "*Muræna optima flutes sunt in Sicilia.*"—*Varr. R. R. II. 6. 2.*

small Sicilian eel, which has seven holes on each side; an etymology which will probably be as new to our readers as it was to ourselves. The children also received their share of instruction and amusement upon this occasion. Tom, for the first time, became acquainted with the use of the pea in the whistle, which, he was told, was to agitate and break the current of air, and thus to produce a succession of quick vibrations, upon which the acuteness of its sound depended. Louisa exhibited her *whis-gig*, which, for the information of the unlearned reader, we may state to consist of a hollow disk of wood, having an opening in its side, like that in the humming-top: by the alternate coiling and uncoiling of the cord upon which it is strung it receives a circular motion, the rapidity of which produces, by means of its opening, an aerial vibration that gives a loud ringing sound.

"I should very much like to hear your opinion of that Egyptian wonder, the statue of Memnon," said the vicar.

"Its history," answered Mr. Seymour, "is involved in considerable doubt and difficulty. Authors of credit agree in stating that it certainly saluted the rising sun with a musical sound; but doubts are still entertained as to the cause which produced it, whether it was the effect of mechanism, or a juggle of the Egyptian priests. An English traveler, Sir A. Smith, informs us that he visited the statue, and actually heard the sounds at six o'clock in the morning; but he believes that they proceeded, not from the figure, but from the pedestal, and he considers that they may arise from the impulse of the air upon the stones of which it is constructed. Others have supposed that the heat of the sun's rays, concentrated by a mirror, may have acted upon plates of metal so as to produce the effect. It is not my intention to argue this point; but I will show you an experiment, by which you will, I think, be convinced that a statue might easily be constructed like the Memnon to yield musical sounds by the application of heat, whether derived from the solar rays, or from any other source."

Mr. Seymour produced a piece of apparatus, of which we

here present the reader with a sketch. It consists of an oblong block of copper, one surface of which is flat, the other formed by two planes meeting at an obtuse angle, and having a groove at the point of junction A. To this block a handle is affixed.



Mr. Seymour, having thus described the form of the instrument, and stated that its construction was solely directed with a view of making it oscillate freely on any plane surface, thrust the block in the fire, and, when sufficiently heated, placed it on its angular surface, upon a flat piece of lead. It immediately began to vibrate, producing, at first, a kind of singing noise, not unlike that of the simmering of a tea-kettle, but the vibrations became more and more rapid until a distinct musical sound was produced, which from time to time varied in its pitch, and gave rise to an effect scarcely inferior to that of the Eolian harp.

"How extremely beautiful!" said Miss Villers.

"And how admirably does it illustrate the theory of musical sounds!" observed Mr. Seymour. "We have here, you perceive, a series of impulses communicated to our ears by the air, at first in slow succession, and by degrees more and more rapidly; at first we hear a rattling noise, then a low murmur, and then a hum, which by degrees acquires the character of a musical note, rising higher and higher in acuteness. It is evident, therefore, from this experiment alone, by showing the correspondence which exists between the pitch of the note and the rapidity of the succession of the vibrations, that our sensation of the different pitches of musical notes originates in the different rapidities with which their impulses are communicated to our ears."

"Pray explain to us the manner in which the block of metal is thus made to vibrate," said Miss Villers.

"It depends," replied Mr. Seymour, "upon the alternate contraction of the two opposite edges of the metal from the



loss of heat; one of the edges coming in contact with the cold lead contracts, and, by destroying the balance of the block, causes its opposite edge to come into contact with the lead, and to undergo the same change; and it is by this alternate action that a rapid vibration is produced, occasioning, as you will now readily understand, the musical sounds you have just heard."

Miss Villers here made some interesting remarks upon the sounds produced by flowing water. "In the fountain," she said, "musical tones are produced by vibrations occasioned by the drops on the jet, and reciprocated by the surface on which they fall."

The lecture having been concluded, Mrs. Seymour proposed that the party should at once proceed to the valley, but the vicar suggested the propriety of first explaining to the children the principle upon which the echo depended.

Mr. Seymour concurred in this opinion, and immediately afforded the following explanation:—"An echo is nothing more than a reflected sound. When the aerial vibrations strike against any obstacle of sufficient magnitude, they are reflected back to the ear, and produce a repetition of the sound, which will appear to proceed from the point whence they are reflected, so that the apparent direction of the voice becomes completely changed by an echo. A considerable extent of level wall will sometimes produce it in great perfection; for a smooth surface reflects sounds much better than a rough one: but the circumstance which, perhaps, contributes more than any other to the perfection of an echo, is the form of the reflecting surface; a convex surface is a very bad reflector of sound, a flat one reflects very well, but a small degree of concavity is the form best adapted to the purpose."

"I believe," observed the vicar, "that fluid bodies will also, under certain circumstances, so reflect sound as to produce echoes."

"Undoubtedly. The surface of water, especially at the bottom of a well, and sometimes even clouds, will produce this effect, as, during a tempest, the continued rolling of the

thunder is nothing but the reverberation of a single discharge bandied about from cloud to cloud."

"Do you mean to say, papa," asked Tom, "that sound is reflected from an obstacle to the ear, in the same manner as my ball is reflected after striking the wall?"

"Certainly; supposing, of course, that your ball is perfectly elastic; and in that case, you no doubt remember the direction it will follow."

"It will always make the angle of *reflection* equal to the angle of *incidence*,"\* said Tom.

"Undoubtedly; and so it is with sound, since air, as you know, is perfectly elastic. If, therefore, the vibrations fall perpendicularly on the obstacle, they are reflected back in the same line; if obliquely, the sound returns obliquely in the opposite direction, the angle of reflection being equal to that of incidence. You will, therefore, readily perceive," continued Mr. Seymour, addressing his conversation more particularly to Miss Villers, "that a person situated at an appropriate angle may hear an echo, as it is returned from the reflecting surface, without hearing the original sound which produced it. M. Genefay has described, as existing near Rouen, a curious oblique echo which is not heard by the person who emits the sound. A person who sings hears only his own voice, while those who listen hear only the echo."

"As a smooth and concave surface is capable of producing an echo, how does it happen that we so rarely meet with one in a room?" asked Louisa.

"Echoes, my dear, are, in fact, produced in every room, by the reverberation of sound from its walls; but on account of the velocity with which it travels, they are imperceptible in small chambers, because the sound occupies no sensible period of time in moving from the mouth to the walls, and in returning back to the ear again; consequently the original sound and its echo become so blended and incorporated, as to appear but one sound. As the dimensions of the apartment

\* The reader is requested to turn to page 184; for all that is there said respecting the principle of *reflected* motion will apply to the theory of the echo.

increase, the defect will increase with it; and, in buildings for music or public speaking, it is often highly inconvenient, and difficult of prevention.\* Breaking the surface, or rendering it uneven by mouldings and ornaments, appears to be the most effectual method of curing the evil."

"I perceive then, papa, that in order to produce a perfect echo, the person who speaks must be at a considerable distance from the obstacle that reflects the sound," said Louisa.

"It cannot be otherwise," replied her father; "and if you will only consider the rate at which sound travels, you will readily understand the necessity of such an arrangement. In order to produce a distinct echo of one syllable, or of a single sound, the reflecting obstacle must be at least 70 feet from the sound, so that it may have to pass through a distance of 70 feet to get to the reflector, and 70 more to return to the ear, making a total passage of 140 feet, which it will accomplish in rather less than one-eighth of a second; a period of time so small, that, if it were diminished, it is evident the echo must be assimilated with the sound itself."

"But the echo in the valley," observed Mrs. Seymour, "will repeat four or five syllables."

"Undoubtedly; if we make the experiment at a sufficient distance from the sandstone rocks which act as the reflector."

"It would appear, then, that the further the reflecting object is off, the greater number of syllables will the echo repeat; and I should think that this fact might enable us to compute the distance of the reflector," said Mrs. Seymour.

"In a moderate way of speaking, about three and a half syllables are pronounced in one second, or seven syllables in two seconds; when an echo, therefore, repeats seven syllables, we may infer that the reflecting object is 1142 feet distant."

"But, my dear Mr. Seymour, this must surely depend upon the nature of the syllables," said the vicar. "Pray excuse the interruption; but you will admit that there must

\* This is very remarkable in the new mineralogical lecture-room in the public library at Cambridge.

exist a great difference between the echo of dactyles and spondees. Suppose an echo should be able to return ten syllables; thus—'*Tityre, tu patula recubans*'—I will be bound for it, that if you were to try its powers in slow heavy spondees, as *monstrum horrendum*, a return of not more than four or five syllables could be observed."

"I will not dispute that point," said Mr. Seymour; "or take, if you will, the famous passage in the Tenth Odyssey, where Sisyphus rolls the stone up the mountain in spondees, and allows it to run down in a torrent of dactyles."

Louisa here remarked that she had often heard of some very extraordinary echoes in different parts of the world, to which her father had not alluded; she mentioned, for instance, those which are said to repeat the same sound several times in succession.

"From the explanation which I have already given of the nature of echoes," said Mr. Seymour, "it will be easily conceived that a vast variety of effects may be produced by varying the form, the shape, the distance, and the number of reflecting surfaces; and hence we hear of various surprising echoes in different places. It is not difficult, for instance, to understand the nature of compound, or tautological echoes; in which case the expression of one *ha* will appear like a laugh-ter. Addison mentions an extraordinary instance of this kind near Milan, which will return the sound of a pistol fifty-six times."

"I have understood that the echoes on the lakes of Killarney are of this multiplied description," said the vicar.

"They are particularly calculated to produce reflections of sound, from the height of the mountains, and the expanse of water," replied Mr. Seymour; "which latter circumstance always assists the conveyance of reflected as well as direct sound. I believe there is a certain spot on the shore of Ross island, where the sound of a bugle produces an echo which far exceeds any other to be met with among the lakes; the first echo is returned from the castle, the second from the ruined church of Aghadoe, the third from Mangerton, and af-

terward innumerable reverberations are distinguished, which, like the faded brilliancy of an extremely multiplied reflection, are lost by distance and repetition."

"There is an admirable echo," said the vicar, "behind my old college at Cambridge; and often have I, while walking on the road to Chesterton, on a calm evening, distinctly heard twelve repetitions of the voice. Lord Bacon, if I remember correctly, mentions an instance of sixteen, in some ruined church near Paris."

"It was in the church of Pont-Charenton, on the Seine," replied Mr. Seymour; "in which place that great philosopher discovered the inability of an echo to return the letter S; for having pronounced the word *satan*, the echo replied *ea-t-en-away*; from which circumstance, the Parisians concluded that some guardian spirit prevented the walls of the sacred edifice from pronouncing the name of *Satan*."

"And will not an echo repeat the letter S?" asked Louisa.

"Not always," answered her father; "the hissing or sibilant noise of the letter, when at the commencement of a word, is generally lost, unless the echo be extremely perfect."

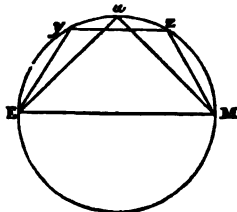
Mr. Seymour was here reminded of an echo on the Rhine, near the ruins of Rheinfels, to which is usually addressed the question—"Who is the Mayor of Oberwesel?" the echo answers *Esel*, —an Ass.

"To be sure," said the vicar, "the latter syllables returned by the echo are those which retain possession of the ear. My young friends, no doubt, remember the facetious dialogue between Juvenis and Echo in the colloquy of Erasmus, in which a very humorous application is made of this circumstance."

## CHAPTER XI.

THE WHISPERING GALLERY IN THE DOME OF ST. PAUL'S.—THE SPEAKING TRUMPET.—THE INVISIBLE GIRL, AND THE AMUSEMENT SHE OCCASIONED.—CHARADES.—OTHER ACOUSTIC AMUSEMENTS.—MYSTERIOUS SOUNDS.—CREAKING SHOES.

ON their return to the Lodge, Mr. Seymour proceeded with the explanation of the Whispering Gallery in St. Paul's Cathedral; and, in order to render intelligible the manner in which sound is concentrated, and thereby magnified, in that hollow hemisphere, he produced a diagram, of which the annexed cut is a copy.



He explained it as follows:

"M shows the situation of the mouth of the speaker, and E that of the ear of the hearer. Now, since sound radiates in all directions, a part of it will proceed directly from M to E, while other rays of it will proceed from M to u, and from M to z, &c.; but the ray that impinges upon u will be reflected to E, while that which first touches z will be reflected to y, and from thence to E; and so of all intermediate rays, which are omitted in the figure, to avoid confusion. It is evident,

therefore, that the sound at  $x$  will be much stronger than if it had proceeded immediately from  $m$  without the assistance of the dome; for, in that case, the rays at  $s$  and  $u$  would have proceeded in straight lines, and consequently could never have arrived at the point  $x$ ."

"I have understood that a similar effect was formerly witnessed in the stone recesses on Westminster Bridge," said the vicar.

"That is the fact," replied Mr. Seymour. "The recesses to which you allude were semi-domes; and if a person whispered in the focus of one of them, he was distinctly heard by another stationed in the focus of the opposite one. Two inanimate busts may be thus made to appear as if holding a conversation, by placing them in the foci of two large concave mirrors constructed of pasteboard, and arranged opposite to each other; when a whisper uttered to the one will seem to proceed from the other by the reflection of sound."

Mr. Seymour now removed a shell from a group of coral-reefs, which decorated a part of the temple, and desired Tom to place it to his ear.

"I hear a noise which appears to me to resemble that of the sea," cried Tom.

"Ay," said the vicar, "and there is a popular belief that it is the murmur of the sea, which the shell actually sends forth, betraying, as it were, its marine origin."

"And what produces the sound?" inquired Louisa.

"The interior of the shell merely concentrates, and thus magnifies the sounds around us, so as to render them audible: a goblet applied to the ear will be found to produce the same effect," replied her father.

"I suppose it is upon the same principle that the speaking-trumpet is made to convey sound to a distance," remarked Louisa.

"Since sound radiates in all directions, it follows that, if such radiation be prevented by confining it in tubes, it may be carried to a great distance with very little diminution of its effect; and hence the use and application of those trum-

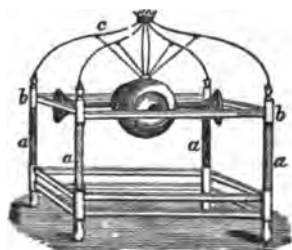
pets, or tin speaking-pipes, which are now commonly used for conveying intelligence from one part of a house to another. The trumpet used by deaf persons acts on the same principle; but as the voice enters the trumpet at the large instead of the small end of the instrument, it is not so much confined, nor is the sound so much increased."

"I believe," said Mrs. Seymour, "that the experiment exhibited some time since in London under the title of the *Invisible Girl*, and which excited such general curiosity, was discovered to depend upon an arrangement of this kind."

The vicar observed, that it was found out by his late friend Dr. Milner, the learned and scientific President of Queen's College, Cambridge.

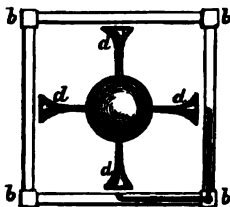
"I expected that you would allude to that exhibition," said Mr. Seymour; "and as I was anxious to provide my young pupils with some new amusement, as a reward for their industry, I have directed Tom Plank to construct the necessary apparatus for exhibiting and explaining the deception."

Upon inquiry, Mr. Seymour found, as he had anticipated, that the necessary apparatus for the experiment of the "Invisible Girl" had been duly arranged, and that Tom Plank was in attendance to afford any assistance which might be further required. We shall proceed to describe all the visible mechanism, as it appeared to the children on entering Mr. Seymour's study, and of which we here present the reader with a perspective sketch.





It consisted of a wooden frame, not very unlike a bedstead, having four upright posts, *a a a a*, and a cross-rail at top and bottom to strengthen them. The frame thus constructed stood upon a low table, and from the top of each of the four pillars sprang four bent brass wires, which converged to the point *c*. From these wires a hollow copper ball was suspended by ribbons, so as to cut off all possible communication with the frame. The globe was supposed to contain the invisible being, as the voice apparently proceeded from the interior of it; and for this purpose it was equipped with the mouths of four trumpets, placed around it in a horizontal direction, and at right angles to each other, as shown in the annexed section, in which the globe is represented in the center; *d d d d* are the trumpets, and *b b b b* the frames surrounding them, at a distance of about half an inch from their mouths. Such as we have described was the apparatus, which had been constructed under the direction of Mr. Seymour, who informed the party that if any of them would ask a question of his little fairy, and direct the voice into one of the trumpets, an answer would immediately be returned from the ball.



"Let me interrogate her," exclaimed Louisa, as she advanced toward the railing. "Tell me, mysterious being, the name of the person who now addresses you."

"Miss Louisa Seymour," answered a voice sufficiently audible to Louisa, and yet so distant and feeble, that it appeared as if coming from a very diminutive being, and thus heightened the deception.

"Now, Vicar, it is your turn," said Mr. Seymour.

"Well, then, I will try whether I cannot puzzle your Delphic lady;" and accordingly, applying his mouth to the trumpet, Mr. Twaddleton demanded an interpretation of the following charade:—"My *First* makes my *Second*, and fancies he is my *Whole*!"

"What is her answer?" anxiously inquired the party.

"As prompt as it is correct. She tells me it is PATRIOT."

"Let Miss Villers advance; she has so lately distinguished herself by her beautiful enigma, that I have no doubt she will now favor us with one that will try the skill of the Oracle, and delight us with its composition," said Mrs. Seymour.

"After that very pretty speech, it would be affectation on my part to refuse; but you really, my dear Mrs. Seymour, place too great a value upon my humble efforts." Miss Villers, accordingly, slowly and distinctly enunciated the following lines in the ear of the trumpet:

"My *First's* a conveyance that's oft on the stand,  
And yet none more private careers in the land;  
Nor wheels, nor e'en horses, are for it e'er needed,  
And still by five couriers 'tis ever preceded.  
So quick has it moved that, in England on Sunday,  
It's been found in the midst of Morocco on Monday.  
When by rough work and wearing 'tis no longer sound,  
By applying my *Second* a cure has been found.  
My *Whole* is a terror to all who may travel;  
So pray, gentle lady, this riddle unravel."

"Who can make it out?" asked Tom.

"Have patience for the response," said the vicar.

"She tells me she requires time," observed Miss Villers.

"Very well: lend your ear, and let us know when the inspiration comes upon her."

"She now rings a bell to announce, I suppose, that she is ready with her answer. Yes; here it is:"

"To unravel your riddle I quickly essay'd,  
With what skill you will presently learn:  
That is, if my answer, in riddle convey'd,  
Is by you understood in its turn.  
Know, then, that your *First* is lively and gay,  
Though of food it never can taste,  
And still it forever is picking away,  
Except when it travels in haste.

All wet is its horror, so tender its frame,  
And yet at a spring it will jump,  
But what must appear a strange part of its game,  
To keep dry it will fly to a pump!  
When tender or tired, how refresh'd by green grass!  
As it wanders through meadow or lawn,  
Yet it is not a horse, a cow, or an ass,  
For it hates ev'ry species of corn.  
Of your *SECOND*, my friend, I've a story in store,  
That perhaps may give you a shock,  
For I found it attach'd to Newgate's dark door  
The moment I wrench'd off its lock.  
In the cell thus exposed I most anxiously look'd,  
And saw, with the eye of a mole,  
A wretch there immured, and for punishment book'd,  
And in him I discover'd your *WHOLE*."

"Now, then, who is prepared to interpret the Sibyl's answer?" asked the vicar.

"I believe I can guess its meaning," answered Mr. Seymour. And well he might, for he had concocted the whole affair in concert with Miss Villers.

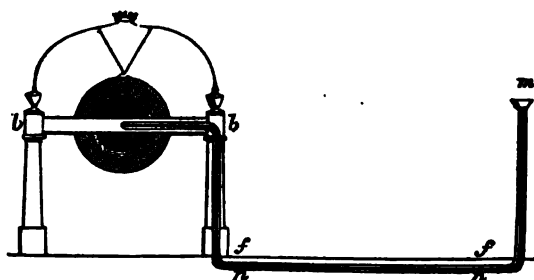
After much questioning and puzzling, as usually happens upon such occasions, Mrs. Seymour declared the mysterious word to be *FOOTPAD*; and she was right, and the rest of the party concurred in that decision; although there was one point that Tom did not comprehend, and that was how the *Second* could be "found on Newgate's dark door."

"Why, my dear," said the vicar, "even dull as I usually am upon these occasions, I very readily solved that mystery. Did he not find a *Padlock* upon '*Newgate's dark door*?' and by taking off the lock, leave his '*second*,' *PAD*?"

The charade having been thus explained to the satisfaction of the whole party, the next question which engaged their attention was the construction of the apparatus, by which the voice was so mysteriously conveyed to the ear.

Tom examined the ball, the trumpets, and the framework; but he was unable to discover any clew by which he could unravel the mystery. At length Mr. Seymour proceeded to

the explanation. He told them that the mechanism owed its effects to the combined operation of two principles with which they were already acquainted; the concentration and conveyance of sound by means of a speaking-pipe, and its reflection from an appropriate surface so as to change its apparent direction, by producing an artificial echo. He then showed them the pipe which was concealed in one of the legs of the frame, and explained in what manner the voice of Tom Plank, who had been stationed in an adjoining room, was conveyed to the mouth of the trumpet, and thence reflected to the ear of the observer. By means of the annexed section, we shall hope to render this subject as intelligible to our readers, as did Mr. Seymour to his little pupils.



*b b* represent two of the legs of the frame, one of which, as well as half the rail, is made into a tube, the end of which opens immediately opposite to the center of the trumpet. This hole is very small, and concealed by moldings; the other end communicates by a tin pipe *p p*, which passes in a concealed manner along the floor of the room, into an adjoining closet, where the confederate is concealed. It is evident that any sound, directed into the mouth of the trumpet, will be immediately reflected back to the orifice of the tube, and distinctly heard by a person who places his ear to the mouth of the funnel *m*; while the answer returned by him, traveling along the tin funnel *p p*, will issue from its con-

sealed orifice, and striking upon the concave surface of the trumpet, be returned to the ear as an echo, and thus appear as if it had proceeded from the interior of the ball.

The vicar observed, that this deception of the *Invisible Girl*, which had formerly created so much interest, was little more than the revival of the old and well-known mechanism of the *speaking bust*, which consisted of a tube, from the mouth of a bust, leading to a confederate in an adjoining room, and of another tube to the same place, ending in the ear of the figure; by the latter of which a sound whispered in the ear of the bust was immediately carried to the confederate, who instantly returned an answer by the other tube, ending in the mouth of the figure, which therefore appeared to utter it. "The Invisible Girl," continued the vicar, "evidently only differs from that contrivance in this single circumstance, that an artificial echo is produced by means of the trumpet, and thus the sound no longer appears to proceed in its original direction."

"Your remark is perfectly correct, my dear vicar," said Mr. Seymour.

Tom Plank, with an air of self-satisfaction, at this moment emerged from his retreat, and inquired whether his performance had met with the approbation of the company.

"Gentlemen," said Tom Plank, "as I am now fully satisfied that any plan of propelling live and dead luggage through funnels can never succeed, I propose to employ tubes for conveying sounds to a great distance, so as to do away with the use of telegraphs."

"Why that plan is more practicable, but less novel, than the one you have just abandoned," answered Mr. Seymour. "At the latter end of the last century, a man of the name of Gautier conceived a method of transmitting articulate sounds to an immense distance. He proposed the construction of horizontal tunnels that should widen at their extremities, by means of which the ticking of a watch might be heard more distinctly at the distance of two hundred feet than when placed close to the ear. I think he calculated that a succession of

such tunnels would transmit a verbal message nine hundred miles in an hour." (17)

"Only think of that!" ejaculated Tom Plank; "to make a communication from London to Edinburgh in about twenty-five minutes!"

"True, my friend; but what would you say, were I to suggest a method of communicating information to any distance without the loss even of a single second of time?"

"There now!" cried the vicar, "you have supplied Tom Plank with some fresh barm to set his brains working."

"He is an indefatigable fellow, I must allow," said Mr. Seymour.

After this discourse the vicar rose from his seat, and on walking across the room, the creaking of his shoes excited the attention of Mr. Seymour, who, with his accustomed gayety, observed, that "the vicar had music in his *sole*."

"Mr. Seymour!" exclaimed Mr. Twaddleton, with a look which we should in vain endeavor to describe, "the infirmity of my shoes, *crepitus crepidæ*, is at all events sanctioned by high antiquity; for we are told by Philostratus, in his Epistles, that Vulcan, being jealous of Venus, made her creaking shoes, in order that he might hear whenever she stirred."

So ludicrous an appeal to antiquity would have overcome Heraclitus himself; no wonder then that the whole party enjoyed a hearty laugh at the worthy vicar's expense.

"Well, Mr. Twaddleton, if, as you say, I have brought down philosophy to account for the most familiar occurrences, it is but just that I should return the compliment, by declaring that you are equally prepared to throw a classical interest around the humblest as well as the most dignified subject, *a capite usque ad calcem*," observed Mr. Seymour.

"Now, Tom, as you have so lately been instructed in the different sources of sound, do tell your good friend, the vicar, the cause of the creaking of his shoes," said his father.

"The dryness of the leather, I suppose," answered the young philosopher.

"A certain state of dryness is certainly a necessary condi-

tion, or else the cohesion between the inner and outer sole would exclude the air. Correctly speaking, the creaking depends upon the sudden compression of the air contained between the two surfaces of leather; just as a sound is produced by the clapping of the hands by the air thus set in vibration. Shoes with single soles, therefore, never creak, and by interposing a piece of oil-silk between the two soles, you will so far insure the contact of their surfaces as to obviate the sound."

"That is at all events a piece of practical philosophy worth knowing; and I shall accordingly instruct my operator, Jerry Styles, upon this point," observed the vicar.

"So you see, my dear sir, I am no bad shoemaker, although I have never yet made a shoe."

"To be sure—to be sure," exclaimed the vicar; "for as Horace has it—

'..... sapiens crepidas sibi nunquam  
Nec soleas fecit: autor tamen est sapiens.'"<sup>\*</sup>

*Hor., lib. i., sat. 8.*

"You never made a happier quotation," exclaimed Mr. Seymour.

"I have only one other remark to make," continued he, "which the consideration of this subject has very naturally suggested—that the various strange sounds, which have from time to time alarmed the superstitious, may be readily explained upon the simple principles we have been discussing. I well remember a whole family having been thrown into a state of terror, by a mysterious sound which regularly recurred every evening; when it was at length discovered to arise from the crawling of snails over the window; their slimy surfaces, as they moved along, produced a friction, which occasioned a vibration of the glass."

"And I never recall to my recollection, without some degree of terror," said the vicar, "the night I passed in an old shaken chamber which had the reputation of being haunted.

<sup>\*</sup> "For though the wise nor shoes nor slippers made  
He's yet a skillful shoemaker by trade."

A bright fire cheerfully blazed in the grate as I entered the apartment, and casting its ruddy light around, in some measure dissipated the prejudice which had been raised to the disparagement of my dormitory; but awaking in the night, my fire was out, and a succession of the most extraordinary noises I ever heard assailed me."

"All which are easily explicable," said Mr. Seymour. "The old oaken materials were expanded by the heat of your fire, and on the apartment cooling, they again contracted, and gave origin to all the sounds you describe."

"How unsparingly does science clip the wings of imagination!" observed Miss Villers.

"Reverting to the subject of shoemaking," said Mr. Seymour, "let me ask the vicar, whether he remembers the receipt of Orator Henley, for making a pair in a few minutes."

"I remember it well: he collected a number of shoemakers by promising to impart his great secret to them; and this wonderful abridgment of time and labor was exhibited to his gaping auditors by cutting off the tops of a ready-made pair of boots!"

"I think," said Mr. Seymour, "when Tom has solved the enigma I am about to propose, you will allow that, as a paradoxical shoemaker, I have fairly beaten the orator out of the field."

"A shoemaker once made shoes without leather,  
With all the four elements joined together;  
There were FIRE, and WATER, and EARTH too, and AIR,  
And most of his customers wanted two pair."





## CHAPTER XII.

THE FLOWER-GARDEN.—EARLY PASSION FOR FLOWERS ENDURES THROUGH LIFE.—ADVANTAGES ARISING FROM THEIR CULTIVATION.—ITS PLEASURES ENHANCED BY THE APPLICATIONS OF SCIENCE.—CONTRAST, A SOURCE OF PLEASURE.—ILLUSTRATIONS.—THE PHILOSOPHY OF COLORS.—COMPLEMENTARY, OR ACCIDENTAL COLORS.—EXPERIMENTS WITH COLORED WAFERS.—OPTICAL FALLACIES.—REFLECTIONS IN THE ALCOVE OF THE MAJOR'S GARDEN.—PRACTICAL SUGGESTIONS AND CONCLUSIONS.

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THE reader will remember that a promise had been given by Miss Villers to visit Osterley Park, in company with the Seymour family, in order that they might inspect and arrange the flower-garden of Major Snapwell. That promise had been redeemed, and on the morning following their arrival, the gallant host reminded Miss Villers of her engagement to offer such suggestions for the improvement of his flower-beds, as might readily occur to a person of her acknowledged taste.

"Nay, my dear major, rather appeal to our good friend Mr. Seymour, since it is from his science alone, that you can expect any really useful hints for the more skillful disposition of your flowers," answered Miss Villers.

"Previous to our entering upon this subject," interposed the vicar, "may I be allowed, my dear major, to congratulate you on having your flower-garden so close to your mansion; when so placed, it inspires very different feelings from one situated at a distance; in the former case, each flower is a *friend*, with whom you may hourly hold converse; you trace its growth from the opening bud to the falling blossom."

"So entirely do I agree with every word that has fallen from our friend the vicar, that I would earnestly entreat every true votary of our elegant science, to place the shrine

of his goddess within a readily accessible distance of his dwelling," observed Mr. Seymour.

"Do you not remember," asked Tom, "when we laid out our little gardens, how desirous you were that they should be placed at a short distance from the house, so that we might watch the progress of our flowers, and the effect produced upon them by daily attention; and as long as I live I shall never forget the pleasure they so constantly gave us, during the holidays."

The artlessness and truth with which this genuine feeling was expressed, particularly struck and pleased Miss Villers, and led her to remark that, with the exception perhaps of certain musical airs, nothing so tenaciously clings to the memory, or entwines itself so passionately around our affections, as an early love of flowers; that the violet and primrose, gathered in our childhood, carry with them the most endearing reminiscences, and the most pleasurable associations, to extreme old age. "The sojourner of distant lands," continued the young lady, "actually weeps with joy over the violet that may have casually found its way to the country of his adoption."\*

Mr. Seymour always considered the cultivation of a flower-garden as very properly included within the instructive recreations of youth.

"There cannot," said he, "be a more healthy and rational amusement. The contemplation of the softer beauties, which a beneficent Providence has so profusely lavished upon us, communicates a sympathetic influence, which not only educates the mind, but refines the heart, and leads the young scholar to look 'through Nature, up to Nature's God.'—The vigilance and kindly care, too, with which we watch, and provide for the tender plant during its progressive stages,

\* It is related that a vessel on arriving in New Holland, and importing for the first time some primroses into the colony, produced such excitement amongst the English settlers, as to have rendered it necessary for the authorities to call out a guard to protect the desired treasure; and it is recorded of Linnaeus that, in his travels through England, he shed tears of joy on recognizing the golden gorse of his native land.

furnish a wholesome discipline of the affections; while, at the same time, we are practically taught the great physical as well as moral truth, that the success of every enterprise will depend upon the due appliances of time and season. The opening foliage, bursting bud, and expanding flower become associated in the young mind with the cheering ideas of hope, progress, and fulfillment."

"I am unwilling to interrupt your flow of eloquence, so powerfully exerted for a high moral purpose," said the vicar, "but never let us forget to impress upon the young mind, that the gratifications afforded by the contemplation of Nature must ever be commensurate with the knowledge of her laws and harmonies—that Science can call up beauties, and unfold charms, unknown and unperceived by the common observer—

'A primrose by a river's brim,  
A yellow primrose is to him,  
But it is nothing more.'

"I can assure you," replied Mr. Seymour, "that my chief object in the proposed examination of the major's flower-garden is to realize what you have so happily expressed, and which you will be pleased to remember I have advocated on many former occasions. It is my present intention to convince our young party that Science, relaxing her sterner aspect, may be found indulging her fancy in the flower-garden, and may even be caught by the young florist, in a kind of holiday humor, coquetting with the Muses, and sporting amidst its gaudy parterres."

"If I correctly understand Mr. Seymour," observed the major, "he is prepared to point out the relations which subsist between certain colors, and the agreeable arrangement of flowers; but before we proceed," continued he, "I should much like to ask whether those who have investigated the natural sources of the beautiful have not justly concluded in acknowledging *Contrast* as one of its most important conditions? and, if so, whether that principle should not be

carried out in the arrangement and distribution of our flowers?"

Mr. Seymour admitted, without any hesitation, that *Contrast* necessarily entered into all our conceptions of the beautiful; "for," said he, "without darkness, we should be scarcely conscious of the reality of light; and it is equally evident that, to render light charming to the senses, we must have shade as an accompanying contrast; even the rainbow owes much of its beauty to the dark cloud of rain, upon which its gorgeous colors appear in such striking opposition. And when does the clear blue sky ever appear so lively and charming, as when viewed through the openings of shadowing trees?"

"Nothing can be more true, according to my views and experience," observed the vicar; "and let me ask, in my turn, wherein would be found the beauties of the most magnificent temples of Greece, if deprived of the happy alternation of lights and shadows? And as to our Gothic edifices, I have always regarded their tracery, moldings, and projecting ornaments as ingenious traps for catching them."

"If so," exclaimed the major, "'may their shadows never be less,' for I am a devoted admirer of Gothic architecture."

"There can be no doubt," said Mr. Seymour, "that the alternations of light and shade are always pleasing to the imagination, and indeed they constitute a striking feature of the beautiful; and I think I may be justified in comparing colors when unrelieved by judicious contrast, to lights without shadows, or shadows without lights."

"How vividly does this conversation recall to my recollection the delight I experienced, last summer, on the downs of Sussex, during a short residence at Eastbourne," said Miss Villers, "when, on a breezy day, masses of cloud were rapidly driven across the clear sky, and sunshine and shadow, like wild spirits, chased each other over hill and dale! The bright gleam, as it advanced, shed joy and gladness from its golden wings; while the broad shadow that followed in its train, although for the moment it might sober this feeling of

exhilaration, served at the same time to heighten the expected pleasure of another bright alternation."

Mr. Seymour told his fair companion that it was only under circumstances such as she had so poetically described, that sunlight proclaims its undisputed dominion over our inward feelings: "It is then," said he, "that we yield to the impressions of Nature in one of her most pleasing moods, and discover that sympathetic relations subsist between her external operations and our own internal sensations."

I think we may venture to say, that those who, perchance, have read this description by Miss Villers, will readily acknowledge that they have experienced the same feelings under similar circumstances.

"Am I then to understand, without further discussion, that the arrangement of our flowers is to be directed by the simple law of contrast of colors?" asked the major.

"Not exactly: there is another and a higher consideration to guide us—a principle depending upon *optical* laws; to explain and illustrate which I consider to be my special mission," answered Mr. Seymour.

"*Nunc agite, pueri.* Now, boys, for a holiday frolic with Science in the flower-garden!" joyously shouted the vicar.

"Very good. You are certainly at liberty to give that turn to my expression," said Mr. Seymour; "but you will soon perceive that the principles I am about to explain with reference to the arrangement of flowers, will admit of far more extensive and important applications, or I should have scarcely considered it worth while to enter upon their consideration. After this declaration, the major will probably allow me to proceed without further interruption. Well, then," continued Mr. Seymour, "in the first place, let it be distinctly understood, that philosophers consider *white* light, as it emanates from the sun, as being compounded of, and consequently resolvable into, three *primary* colors, viz.—RED, BLUE, and YELLOW; and that, should such colors be recombined, in their just proportions, they will reproduce white light; and that, moreover, all other colors, such as *orange*,

*green, indigo, and violet*, are compounds of the primaries just mentioned; thus, for instance, green is a compound of blue and yellow—orange, of red and yellow—and purple, of blue and red; and so on.

"When a body, therefore, exhibits a particular color, we may assume that the white light, which has fallen upon its surface, has been resolved into its constituent colors; of which some have been absorbed or extinguished,\* while others have been reflected—the reflected rays meeting the eye are, of course, those which impart to the body in question its characteristic color: thus—if a body appear green, we infer that it has absorbed the red ray and reflected the blue and yellow ones, which, by combining, produce green. The difference of shade, or tone, observable in colored bodies—such, for example, as a light or dark green, or a bright or dark red—arises from their respective surfaces reflecting, in conjunction with the dominant color, other subordinate rays, with a greater or less admixture of white light that had escaped decomposition."

"I believe," interposed the vicar, "that a surface never exclusively reflects any single kind of colored rays."

"I do not believe that there is such a thing as a perfectly unmixed color, excepting of course those transmitted through the prism," answered Mr. Seymour.

"Well," observed the vicar, "I must now acknowledge the error into which I have fallen. You must know that, in anticipation of your lesson, I had prepared a top, which I thought, by spinning rapidly, would enable my young friend to comprehend more readily your theory. I divided its upper surface by radii into three compartments, corresponding to the relative areas occupied by the three primitive colors; and I fully expected that, during the rapid revolution of the top, I should so combine these colors as to have produced a

\* When we say that certain rays are *absorbed*, we use a figurative expression to denote that they have vanished, without reference to the mode of action by which the effect is produced.

pure white; but instead of that, I only obtained a dull and dirty grayish tint."

"And I hope you now fully understand the cause of your disappointment," said Mr. Seymour. "Could you have obtained colors, as pure as those of the prism, you would, beyond doubt, have succeeded. In carrying out our theory, however, we are bound to consider the colors as pure, so that the union of any one with the other two shall produce white light. Now, the colors standing in such relations to each other are very significantly said to be **COMPLEMENTARY** of each other. Thus, red is complementary of green, that is, of blue and yellow, because, to form white light, red must be added to such colors. So again, blue is said to be complementary of orange; although, in some of the more complicated colors, it is not always easy to fix upon their exact complements."

Mr. Seymour next proceeded to consider certain effects produced by white and colored light upon human vision; and for this purpose he thought the readiest and most satisfactory way would be, at once, to exhibit a simple and, as he thought, a very instructive and convincing experiment. He accordingly attached to a white card three differently colored wafers, in the figure of a triangle; and stated that, if the eye be steadily fixed upon them for a few seconds, and then turned away and directed to a blank part of the card, the image of the wafers would be seen of the same form and dimensions, but in colors complementary of those of the real wafers.

"Do you mean to say, papa," asked Tom, with some surprise, "that, after looking at the red wafer, I shall see its ghost of a green color, by merely turning my eyes to a blank part of the paper?"

"Yes, my dear boy, that is precisely my meaning; but do not trust my word, let your eyes judge for themselves."

Tom obeyed his father's directions, and readily saw the three wafers of different colors, but "more faint," as he said, "than the real ones. I see," said he, "the red wafer now green, the violet one yellow, and the orange one blue."

"I think we all now understand the meaning of *complementary* color; I shall therefore advance another step in the inquiry," said Mr. Seymour. "The unreal, or *spectral* color, you have just witnessed, and which is always complementary of that of the real image, when it is called up in the way you have seen, is said by M. Chevreul to be produced by *SUCCESSIVE* Contrast, to distinguish it from the optical appearance I am now about to exhibit, and which has been termed *SIMULTANEOUS* Contrast. The meaning and value of these words will immediately become apparent, for since in the late experiment the true and complementary colors were seen successively, or the one after the other; so in the experiment I am about to exhibit, the true and spectral colors will be seen together: the terms, therefore, *successive* and *simultaneous* contrasts seem especially well calculated to mark the distinction. In this second experiment, I shall use the same card and the same wafers. Now then, Tom, I again ask you to gaze steadily upon the wafers, as you did before, but without transferring your eye to a blank part of the card, as in the former experiment, and tell me what you see."

"I see," answered the boy, after a short interval, "the three wafers, each bordered by a rim of a different color; the red wafer has a border of green, the violet of yellow, and the orange one of blue."

The major having likewise satisfied himself by ocular demonstration, asked whether he was not to understand from what he had seen, that the eye, in viewing existing colors, sees also, either successively or simultaneously, phantoms of a complementary hue?

"You state the fact very clearly," answered Mr. Seymour, "for those complementary images have no existence but in the mind's eye; they are mere specters called up as it were by enchantment, but they are nevertheless very important in their practical influences; indeed I may say that they furnish the only rational explanation of many appearances which, although familiar, are not the less difficult to comprehend. This must be my apology for having so heavily taxed your



time and patience; and all that now remains for me to do, is to announce the general optical law to be deduced from them, *vis.*: *That when two dissimilar colors are seen in juxtaposition, or when one quickly succeeds the other, they will mutually modify each other, by reciprocally imparting their complementary colors.*"

"Are you prepared to give us some simple instance, in which so modified an effect can be readily witnessed?" asked the major.

"At once," answered Mr. Seymour: "look at this bright-green colored book, just purchased at a railroad station, where hundreds of such evergreens are exposed for sale, and tell me, if you can, the color of its leaves."

"Pink," one and all exclaimed.

"No such thing," said Mr. Seymour, "they are perfectly white, as you will acknowledge, as soon as I turn aside the green cover."

The party were perfectly astonished at this revelation, and amused themselves for some time by fixing their eyes upon the green cover, and then opening the book, in order to witness the complementary color of its pages.

"I will relate a curious anecdote in connection with this optical fallacy," said Mr. Seymour: "being about to start on a railroad, I purchased at the terminus one of these green books to amuse myself during the journey, and on placing a shilling on the cover, I hastily withdrew it, under the impression that I had offered a copper counterfeit, but which immediately regained its silvery hue, as soon as it had been removed from the glare of the green-eyed enchanter. I will add to this another similar anecdote. As I lately passed a shop in the Quadrant, near Regent-street, I observed in the window numerous small articles of silver, displayed on a bright green card; after gazing upon them for a few seconds they appeared as if deeply tarnished, an effect which I soon discovered was due to the complementary color cast upon them by the green ground on which they were exhibited."

"I perceive," said the major, "that this optical theory

most comprise many beautiful applications which I had not at first imagined."

"I could point out many such illustrations which, I doubt not, would greatly interest you; and here again I must be permitted to refer to an observation to which the vicar has frequently drawn our attention—the distinction between seeing and observing, between 'eyes and no eyes,' as Miss Edgeworth would express it. Should the philosopher travel through a country, a large portion of whose surface is covered by a vivid green, enlivened by a bright sun, and interspersed with patches of plowed land, he will not fail to observe that the latter assume a purplish-red color, while hundreds may have passed over the same road without having noticed, much less inquired into the cause of such an appearance."

"I can readily understand that there may be appearances to be alone recognized by an experienced and inquiring eye," observed the major.

"That is undoubtedly the case; and," added Mr. Seymour, "so also are there optical illusions which the uneducated eye will take for realities—thus, many of those diversified tints, which so charm us in the summer sunset, are mere optical creations, being a few bright colors multiplied by the complementary images of our vision; and so also with those colors that occasionally flash across the restless surface of the sea; they are but complementary tints, which the blue or green waves cast upon the intervening spaces."

"How all-important are these few observations, with which you have favored us, to the landscape painter!" said Miss Villers.

"Suppose we now, at once, adjourn to the flower-garden," said the vicar, "where our good friend will find a better opportunity for exemplifying his principles."

This proposition was met by a general assent, and, at the suggestion of the major, the party retired into an alcove, which commanded a full view of the flower-beds, while it afforded an agreeable retreat from the direct rays of the sun.

"Major," said Mr. Seymour, "I commend your taste in bringing together similar flowers in masses; but you should take care that the neighboring clumps, as far as possible, occupy equal areas, and exhibit, as nearly as may be, complementary colors; although I will take this early opportunity to remark, that colors which, in the aggregate, are almost repulsive, may be tolerable, or even pleasing, when presented singly to the eye; for instance, masses of blue and green, unrelieved by other colors, are any thing but agreeable when viewed in juxtaposition; and yet who will not hail with delight that little blue and bright flower, the '*Forget-me-not*,' though embosomed in a mass of green?"

"For the present," said the major, "let us confine our attention to the arrangements of clumps, or masses; each of which we will suppose to consist of different flowers, but in such proportions and proximity, as may conduce to a reciprocal modification of their colors; now, what I expect to obtain from your science is some general guiding principle for the arrangement and disposition of such groups."

"And that information I will endeavor to afford you. In the first place then, take care that your plants are pretty nearly of equal magnitude, or they will resemble an awkward squad with tall and short recruits. Let it be, once for all too, remembered, that complementary colors are never incompatible with each other, their tone, and therefore their beauty, being mutually heightened by a reciprocal exchange of complements; not that I mean to assert that non-complementary colors are always displeasing—I think, as a general rule, colors which possess a common element lose more or less of such element by juxtaposition."

"I understand your meaning: orange and green, each having yellow as a common element, would I presume furnish an example," said the major.

"Undoubtedly; and see what would happen—the orange would appear more red, and the green more blue, or, in other words, each would be deprived of a portion of its yellow," said Mr. Seymour.

"That might be advantageous," suggested the major, "where the one was deficient in red, and the other in blue."

"Exactly so—and the circumstance of the same color being liable to vary so widely in intensity and tone must render it difficult, if not impossible, to lay down any general rule that shall not have many exceptions; but then these exceptions will generally admit of explanation, and will serve to extend the field of observation, and to stimulate inquiry, and thus to afford additional sources of recreation; indeed, what many persons would regard as insuperable obstacles to any thing like a systematic arrangement of colored flowers, I am disposed to consider as affording the highest claims to our regard. In contemplating a group of flowers, the scientific observer will often experience an intuitive feeling of pleasure, or it may be, an undefined impression of dissatisfaction; he will then proceed to examine into the harmonies which may explain the one, and to seek for the discords that may enable him to correct the other—this exercise of the mind constitutes the main pleasure of floral gardening, which never could be derived from a system under the dominion of defined and invariable laws."

"I think you just now stated that green and yellow are not well-assorted companions," observed the vicar; "if so, I should much like to ask you upon what principle it is that the green woods so greatly delight the eye on assuming the livery of autumn?"

"Therein you are deceived," answered Mr. Seymour: "the green passing into yellow is very far from pleasing; the autumnal tints really owe their beauty to their rich and almost endless variety; and I suspect, if it were possible to unweave their gorgeous texture, we should find that the assemblage was resolvable into groups of complementary colors. I think," continued Mr. Seymour, "it must be admitted that colors bearing too close analogy with each other, unless judiciously relieved, will suffer by juxtaposition. I am also disposed to think you will admit, that the different shades of the same color disparage each other: only look at yonder bed of *Dah-*

*lilas*, and say whether they would not be much heightened in beauty by the intermixture of others of somewhat of a complementary character; and so is it with the golden *Jonguill*, when placed side by side with the pale *Narcissus*, the white light of the latter dimming the luster of the former by its complementary sable, while the complementary green of the former imparts an injurious hue to the delicacy of the latter. Let me now, by way of further illustration, direct your attention to yonder *Roses*; those in the bed on the right have far too much yellow to please my eye; they almost assume a faded appearance; while those on the left are too much inclined to blue: now, I would propose, with the major's consent, to bring some strong yellow flowers in contact with the former, and some purple ones in contact with the latter, and I believe these defects would disappear."

"I do not think that your critical eye can find any fault with those blue flowers next to the orange ones," observed the vicar.

"No, indeed—nor with the violet contiguous to the yellow; they appear most cheerful in each other's company; in fact, there are few flowers in the garden in better accord with each other, unless you disturb their harmony by some unwelcome intrusion; but just look at that dull bed of green, near the yellow flowers; on the right of which, near the sun-dial, you will see a similar bed, but then it is in conjunction with a cluster of the vivid red *Verbena*, which lights it up, as it were, with a borrowed splendor, and at once redeems it from the somber appearance which characterizes the former one. You have another good instance of what may be called an ill-matched alliance in yonder beds of *Nasturtium* and *Purple Poppies*: instead of the natural lively scarlet, the former assume a dull orange tint, in consequence of a greenish-orange complement cast upon them; while the latter, oppressed by the greenish-purple complement of the *Nasturtium*, exhibit a tint almost as dull as wine lees."

"You have not yet said one word about white flowers," observed Miss Villers.

"True, madam—generally speaking, a clump of white flowers seen apart will produce but little effect; when, however, they are suitably distributed among those whose colors have been judiciously contrasted, they will occasion a favorable impression; as, for instance, when dispersed among red and pink flowers, surrounded by verdura, or among groups of blue and orange, and of violet and yellow flowers; you will readily perceive that their optical influence will have the effect of extinguishing any excessive or undue reflection of white rays emanating from the neighboring bright flowers, and would thereby purify and heighten their tone."

Miss Villers here begged to ask a question respecting the influence of a predominating green.

Mr. Seymour replied "that the green leaves of flowers did not interfere to the extent generally supposed, since, as soon as the eye distinctly and simultaneously sees two colors in a rich flower-bed, the attention is so riveted upon them, that it passes without notice the contiguous objects which lie in a receding plane, and are of a somber color; besides which, it is a fact that green, in juxtaposition with a mass of bright yellow and blue, so nearly loses its color as to be scarcely recognized, and will certainly not intrude with any optical impertinence."

"After the valuable lesson we have received," said the major, "I think we shall be able to improve greatly the arrangement of my garden. You will be pleased, my dear sir, to accept my best thanks—and what says Miss Villers?"

"That Madam Flora holds a most punctilious court; and expects her flaunting subjects to adopt their costume in strict accordance with the colored dresses with which they may be brought into contact," answered the lady.

To whom Mr. Seymour replied "that Flora was not the only sovereign distinguished by such exactions."

"I understand your allusion," said Miss Villers: "you would intimate that the optical principles you have explained might admit of a wider range of application than that which comprehends the domain of Flora; that they might, for in

stance, suggest to my sex a more harmonious mixture in their colored ribbons and dresses."

"No doubt. Count Rumford long ago made a similar observation; but, strange to say, it has passed unheeded. I fully hope, however, that the exertions of the new 'School of Design' will introduce a purer taste as regards the harmony and disposition of colors, not only in dress, but in furniture, and every species of decoration—but what thinks the vicar?"

"That you have well performed the part of the Sibyl, and safely conducted us through Elysian fields, wherein you have introduced us to phantoms and spectral forms of the highest interest for our instruction, no less than for our amusement; and, as truth alone has been the object we have sought, it only remains for you to dismiss us safely through the appropriate portal."

"I quite understand your meaning," said Mr. Seymour, "though artfully concealed under the shadow of the Muses' wing. You admit the truth of the optical theory I have expounded, but would, at the same time, caution us against the danger of being led by the fascinations of fancy to an exaggerated estimate of the importance of its applications; a caution which I can assure you I very sincerely appreciate."

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## CHAPTER XIII.

A NEW OPTICAL TOY INVENTED BY THE AUTHOR, AND TERMED THE THAUMATROPE.—THE VICAR'S LUDICROUS ALARM AT ITS ANNOUNCEMENT.—EXPLANATION OF ITS PRINCIPLE.—RETENTIVE POWER OF THE RETINA.—SPECTRAL, OR ACCIDENTAL COLORS.—THE CROSS OF CONSTANTINE.—SUGGESTIONS FOR IMPROVING THE THAUMATROPE.—OTHER TOYS UPON THE SAME OPTICAL PRINCIPLE.—PHANTASMA-SCOPE.—PHANAKISTISCOPE.—IMPORTANT CONCLUSION OF THE CHAPTER.

Tom's holidays were now drawing to a close, and the children were summoned into the library to receive their last lesson in philosophy.

"You have lately witnessed an experiment," said Mr. Seymour, "which must have convinced you how liable the ear is to be deluded with respect to the nature and direction of sound; I shall now show you that the eye has also its sources of fallacy."

"If you proceed in this manner, you will make us Cartesians,"\* exclaimed the vicar.

"I shall illustrate my subject by means of a new toy

\* The Cartesians maintained that the senses were the great sources of deception; that every thing with which they present us ought to be suspected as false, or at least dubious, until our reason has confirmed the report.



which I have lately invented," said Mr. Seymour; "and unless I am much mistaken, it will afford as much amusement to the elder as to the younger members of our party, although the vicar may perhaps regard it as a more hostile instrument than even that of the wooden horse which filled unhappy Troy with an armed enemy. It is a small machine," continued Mr. Seymour, "which is well calculated to furnish us with some capital puns and well-pointed epigrams."

"With puns!" exclaimed the horrified vicar, who no sooner heard this appalling declaration, than, like another Laocoon, he deprecated the introduction of the "*donum exitiale*" within the walls of Overton Lodge. But his hostility was soon disarmed, not by the circumvolutions of a snake around the body of the enraged orator, but by the embraces of little Rosa, who threw her arms around the neck of the vicar with such supplicating grace, that at length he exclaimed, "Well, well; if it be the decree of the Fates, I must submit."

During this altercation, Mr. Seymour had procured the "wooden engine" from his study.

"I will first," said he, "exhibit the toy in its original state, and then show you the improvements which have been effected in it."

"Let us hear the account of its operation," said the major, "which I perceive is inclosed within the box."

"True," replied Mr. Seymour; "and I think you will agree that I have given a very plausible explanation of its effects."

"Plausible," muttered the vicar, "plausible enough, no doubt; oh, the-Simon!"

Mr. Seymour then proceeded. "This toy is termed the THAUMATROPE."

"Of Grecian origin!" observed the vicar. "'*Timeo Danaos et dona ferentes*,' as Virgil has it."

"What is the meaning of the term?" asked Louisa.

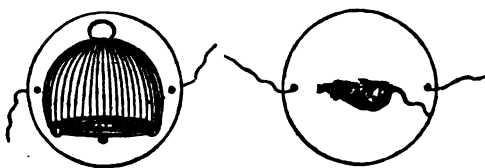
The vicar explained to her that it was compounded of the Greek words *θαύμα* and *τροπή*; the former of which signified *wonder*, the latter *to turn*.

"Exactly," replied Mr. Seymour: "'a Wonder-turner,' or a toy which performs wonders by turning round: but let me proceed in the explanation." He then continued to read as follows: "This philosophical toy is founded upon the well-known optical principle, that an impression made on the retina of the eye lasts for a short interval after the object which produced it has been withdrawn. During the rapid whirling of the card, the figures on each of its sides are presented with such quick transition, that they both appear at the same instant, and thus occasion a very striking and magical effect. On each of these cards a device is introduced, with an appropriate motto or epigram; the point of which is answered, or explained, by the change which the figure assumes during the rapid whirling of the card."

"It may be very clever," said the vicar, "but I do not understand it."

"But you shortly will; look at one of the cards."

Mr. Seymour then displayed a pasteboard circle, on one side of which was figured a rat, and on the other a cage: two strings were fastened in its axis, by which the card could easily be made to revolve, by means of the thumb and finger. Fearing that some of our readers may be as dull of comprehension as the vicar, we have introduced a sketch of the apparatus, in which both sides of the card are exhibited, with the strings by which it is whirled round.



No sooner had Mr. Seymour put the card in motion, than the vicar, in a tone of the greatest surprise, exclaimed, "Magic! magic! I declare the rat is in the cage!"

"And what is the motto?" asked Louisa.

"Why is this rat like an opposition member in the House of Commons who joins the ministry?" replied Mr. Seymour.

"Ha, ha, ha!—excellent!" cried the major, as he read the following answer: "Because by *turning round* he gains a snug birth, but ceases to be free."

"The very reverse to what occurred in ancient Rome, where the slave became free by turning round," observed the vicar.

The vicar, no doubt, alluded to the custom of making a freeman as described by Persius; from which it appears, that the clapping a cap\* on the head, and giving him a turn on the heel, were necessary circumstances. A slave thus qualified became a citizen of Rome, and was honored with a name more than belonged to any of his forefathers, which Persius has repeated with a great deal of humor in his fifth satire:

" . . . Heu steriles veri, quibus una Quiritem  
Vertigo facit!"

"That false enfranchisement with ease is found;  
Slaves are made citizens by turning round."

DRYDEN.

"If we may trust the late report of the American Congress, your '*Thaumatrope*' has also found a political application on the other side of the Atlantic," observed the major; "for it would appear that the Honorable Member of Ohio told the Honorable Member of Carolina, whom he twitted with sudden tergiversation, that he reminded him of *the boy who turned round so fast, that the hinder parts of his dress were on both sides at once.*"†

"Show us another card," said Tom eagerly.

"Here, then, is a watch-box; when I turn it round, you will see the watchman comfortably sleeping at his post."

"Very good! It is very surprising," said the vicar.

\* Hence the *Cap* became the symbol of Liberty.

† "Times," March 2, 1852.

"Yes," observed the major; "and to carry on your political joke, it may be said that, like most worthies who gain a post, by *turning round*, he sleeps over his duty."

"The epigram which accompanies it is not deficient in point," said Mr. Seymour.

"The caprice of this watchman surpasses all bounds,  
He ne'er sits in his box, but when going his *rounds*;  
While he no sooner rests, 'tis a strange paradox!  
Than he flies from his post, and *turns* out of his box!"

"What have you there?" exclaimed the vicar; "arms and legs, without a body?"

"Yes," replied Mr. Seymour; "and which, on turning round, will present the figure of a king, invested with all the insignia of royalty."

"It is indeed a king. Look at his crown and scepter!" cried Louisa.

"Now for the epigram," said the major, who then read the following lines:

"Head, legs, and arms, alone appear;  
Observe that *nobody* is here:  
Napoleon-like, I undertake  
Of nobody a king to make."

The next card presented a laughing face, which, on being turned round, was instantly changed into a weeping one. The motto—*The sweetest things turn sour*.

"The device is capital!" exclaimed the vicar: "I question whether Peter of Cortona ever produced a more striking metamorphosis."\*

The other cards were now exhibited in succession, of which the box contained eighteen, and the whole party, not even

\* Ferdinand, duke of Tuscany, was once struck with the picture of a child crying; the artist (Peter of Cortona), who was at work upon the head, wishing to give a proof of his skill, by a few judicious touches converted the crying into a laughing face. The duke was in astonishment; the painter, to show himself master of the human countenance, restored his first touches, and the duke again saw the child weeping.

excepting the vicar, were highly gratified with the amusement.

"But I have not yet read to you the author's address to the public; and which, I must say, contains a succession of very happy puns."

"Spare me! spare me!" cried the vicar; "I like your toy, but cannot discover the advantage of alloying amusement with such spurious wit, and of associating science with buffoonery."

Mr. Seymour, however, was relentless, and thus proceeded: "It is well known that the Laputan philosopher invented a piece of machinery, by which works could be composed by a mechanical operation; and the 'Quarterly Review' has asserted, that a certain English poem was fabricated in Paris, by the powers of a steam-engine; but the author of the present invention claims for himself the exclusive merit of having first constructed a hand-mill, by which puns and epigrams may be *turned* with as much ease as tunes are played on the hand-organ, and old jokes so *rounded* and changed, as to assume all the airs of originality. The inventor confidently anticipates the favor and patronage of an enlightened and liberal public, on the well-grounded assurance, that '*one good turn* deserves another;' and he trusts that his discovery may afford the happy means of giving activity to wit that has been long *stationery*; of *revolutionizing* the present system of *standing* jokes, and of putting into *rapid circulation* the most approved bon-mots."

"Why, vicar, what ails thee?" exclaimed the major.

"Our subject has given him a *turn*; let him alone and he will soon *come round*," observed Mr. Seymour.

The whole party, with the exception of Mr. Twaddleton, laughed heartily; the vicar, however, did not relax a feature of his countenance; nor would he "though Nestor swear the jest be laughable."\*

As soon as this ebullition had subsided, the major inquired

\* Shakespeare.

of Mr. Seymour, what was the nature of the improvement to which he had alluded.

"My proposed improvements refer both to the subjects exhibited on the cards, and to the mechanism by which their changes are effected," replied Mr. Seymour.

"In the first place, it has occurred to me that this amusing toy might be made instrumental in impressing classical subjects upon the memory of young persons."

This observation delighted the vicar, who said that he would patronize such an attempt with all his heart.

"Why can we not," continued he, "thus represent the *Metamorphoses* of Ovid? or what say you, vicar, to converting the fleet of *Æneas* into sea-nymphs, as Virgil has it?"

"An elegant thought! upon my word; a most elegant conception!" exclaimed Mr. Twaddleton.

"What have we here?" interrupted the major, who had, for the first time, noticed the superscription on the cover of the box; "had I seen this before, I should have augured favorably of the toy: it is like the sign of an inn, which is held out to announce good entertainment within." He then read the following:

The Thaumatrope;  
being  
*Rounds* of Amusement,  
or  
How to please and surprise  
By *Turns*.

Mr. Seymour now proceeded to explain more fully the optical theory of the instrument, which neither Louisa nor Tom could, as yet, thoroughly understand.

He told them that an object was seen by the eye, in consequence of its image being delineated on the retina, or optic nerve, which is situated on the back part of the eye; and that it had been ascertained, by experiment, that the impression which the mind thus receives lasts for about the eighth part of a second after the image is removed. "It is, therefore, sufficiently evident," said Mr. Seymour, "that if any

point, as a lighted stick, be made to revolve, so as to complete the circle in that period, we shall not see a fiery point, but a fiery circle; because the impression made by it in every point of its circuit will remain until it comes round again to the spot from which it set out;—but we will at once exemplify this fact by an experiment.”

Tom was accordingly directed to procure a piece of stick and a candle; and as soon as they were brought into the room, Mr. Seymour ignited the end of the stick and whirled it round, when a bright circle, without any intervals of darkness, was seen by the whole party.

“Never until this instant,” exclaimed the vicar, with an expression of high satisfaction, “did I fully appreciate the beauty of that passage in Milton, wherein the poet evidently describes the rapidity of Satan’s flight, as well as the refulgence of his appearance—

‘Sprung upward like a pyramid of fire.’

Now to take in the full meaning of this figure,” continued Mr. Twaddleton, “we must imagine ourselves in chaos, and that a vast luminous body is rising near the spot where we may be supposed to be standing, so swiftly as to appear a continued track of light, and lessening to the view, according to the increase of distance, until it ends in a point and then disappears; and all this must be supposed to strike our eye at one instant.”

“It is very probable,” said Mr. Seymour, “that the poet had such an idea in view, and that he intended by it to convey the immense rapidity of Satan’s flight. Homer makes use of the same figure to express the velocity of the javelin, *δολιχόσκιον ἔγχος*, the ‘*long-shadowed*’ javelin. We shall have ample proof of the effect of this power in the eye of retaining impressions, and of thus converting points into lines and circles, during the exhibition of your fireworks; and which, in fact, derive the greater part of their magical effect from it.”

“The pin-wheel is certainly nothing more than a fiery cir-

ele produced by the rapid revolution of a jet of flame," said the vicar.

"And the rocket," added Mr. Seymour, "is a column of light occasioned by the same rapid movement of a burning body in a rectilinear or curved direction."

"I perfectly understand all that you have said," observed Tom.

"Then you will not have any difficulty in explaining the action of the Thaumatrope, for it depends upon the same optical principle; the impression made on the retina by the image, which is delineated on one side of the card, is not erased before that which is painted on the opposite side is presented to the eye; and the consequence is, that you see both sides at once."

"Or, you might put it in this way," said the major: "that as the image remains the eighth of a second on the retina, a revolution of eight times in a second will secure its uninterrupted continuance."

"On turning round the card," observed Louisa, "I perceive that every part of the figure is not equally distinct."

"Because every part of the card does not revolve with the same velocity," said her father; "and this fact offers a good illustration of what I formerly stated,\* that in circular motion, the parts more remote from the axis of rotation are those which move with the greater velocity. This toy will also be found capable of exemplifying another truth to which I have before alluded, that the 'axis of motion remains at rest, while all the parts revolve round it.'"<sup>†</sup>

"I remember that very well," exclaimed Tom.

"Then take the card and spin it between yourself and the window, and tell me what you observe," said his father.

"I see a dark line across the window; and what is very strange, the other parts of the card appear transparent; for they do not obstruct the view of the window, as they would if the card were at rest."

"The dark line you see is the axis of rotation; which, be-

\* Page 172.

† Page 62.



ing stationary, necessarily excludes the light; the other parts being in motion do not remain a sufficient time to obliterate the image made on the eye by the window. It is true that the card diak passes between your eye and the light, but, as it does not continue at any one point for more than the eighth of a second, there is no more apparent intermission of the light than what occurs during the winking of the eyes."

"You allude to a very curious fact," observed the vicar, "that, although we are perpetually covering the eyeballs with our eyelids, we are not conscious of the intervals of darkness."

"The reason of which must surely be obvious from the explanation I have just offered," said Mr. Seymour: "the sensation of light is not exchanged for that of darkness in so short a period as the twinkling of the eye. Before we quit the subject," continued Mr. Seymour, "let me point out the great importance of this law of vision. Suppose the image on the retina had vanished at the same time with the withdrawal of the object; we should, in that case, have been unable to see the things immediately around us in due connection with each other; the objects must have appeared isolated, in detached parts, by means of separate impressions which the eye would be unable to combine into a whole, unless indeed they came to us at a very acute angle."

"I admit the plausibility of your theory," said the vicar; "but it appears to me that objects frequently linger on the sight for a longer period than that which you assign to them. I well remember seeing the flame of a candle for several seconds after it had been suddenly withdrawn from the apartment."

"I admit that strong lights frequently continue for some time thus visible in the 'mind's eye;' and it is well known that such impressions are often followed by images of similar shape, successively assuming different colors. In passing from sunshine to a dark room, we also frequently witness the appearance of stars and circles of vari-colored light; but

these '*ocular spectra*' are very distinct from the phenomena of the Thaumatrope, and are to be explained upon very different principles."

"There is also another optical appearance which the knowledge you acquired in the flower-garden at Osterley Park will enable you fully to understand—I allude to the spectral images which become visible after intently gazing upon a colored object, and which you will remember, upon the principle of '*Successive Contrast*,'\* are always of a *complementary* color."

"I know exactly to what you allude," said the major; "and I do not doubt but that many of those illusive appearances which have been described might be referred to the operation of the same natural cause. It is easy to imagine that a person who has steadfastly fixed his eyes upon an illuminated object may for some minutes afterward see the same figure of a dark hue; it may have been from such a cause that Constantine saw the image of a cross in the sky. You are probably acquainted with the opinions of Eusebius, Fabricius, and Dr. Lardner, upon this alleged miracle."

"Yes," added the vicar, "and I also know that this imputed miracle for the conversion of Constantine gave origin to the Catholic custom of illuminating the cross of St. Peter's in Rome."

"Sir David Brewster, in his work on Natural Magic, has given us a beautiful illustration of the same principle; it is as follows," said Mr. Seymour. "A figure dressed in *black*, and mounted upon a *white* horse, was riding along exposed to the bright rays of the sun, which through a small opening in the clouds was throwing its light only upon that part of the landscape. The *black* figure was projected against a white cloud, and the white horse shone with particular brilliancy by its contrast with the dark soil against which it was seen. A person interested in the arrival of such a stranger had been for some time following his movements with intense anxiety; but, upon his disappearance behind a wood, was

\* See chapter xxii. p. 261.

surprised to observe the specter of the mounted stranger in the form of a *white* rider upon a black steed, and this specter was seen for some time in the sky, or upon any pale ground to which the eye was directed."

Miss Villers here remarked that she "had a distant recollection of a somewhat similar appearance having been recorded by Goethe."<sup>\*</sup>

Mr. Seymour added that "from the same cause a devotee before an image might see its spectral form whichever way he turned his eyes; or he might see a luminous border around the head of the saint."

"That I can readily believe," observed the major: "in the former case the appearance would arise from *Succession*, in the latter from *Simultaneous* contrast.—It is gratifying to observe to what an extensive range of subjects this apparently trivial fact is applicable."

"But let us return to the subject of the Thaumatrope," said Mr. Seymour. "Behold!" continued he, "the Trojan ships!"

"Ay, ay, sure enough," said the vicar; "but let me see, are their forms according to ancient authority? Very well indeed, Mr. Seymour; very well: the poops have the bend so accurately described by Ovid and Virgil—'*puppeaque recurva*,' as the poet has it. And there is the triton; but is its size in proportion to the vessel? Yes, sir, you are doubtless correct, the figure is generally represented of considerable magnitude on ancient medals; and Silius Italicus, if my memory serves me, alludes to the weight of the image having on some occasions contributed to the wreck of the vessel."

"Spin them round," said Mr. Seymour.

The vicar complied; exclaiming at the same moment,

<sup>\*</sup> The appearance referred to is thus described by Goethe, in his work on colors: "As it was growing twilight, a black poodle ran by my window in the street, and drew a clear shining appearance after him; the undefined image of his passing form *remaining in the eye*." According to his own acknowledgment, this optical illusion had suggested the introduction of the black dog in his poem of Faust, in which it is described "as ranging through the corn and stubble, with a line of fire following upon his track."

"*'Vos ite solutas. Its dea pelagi.'* They are positively converted into sea-nymphs. '*Miribile monstrum!*'" cried Mr. Twaddleton.

"Here is another classical device; the representation of Eurydice, as she fell lifeless at the moment Orpheus turned round to gaze on her," said Mr. Seymour.

"Charming! charming! I perceive that it is a copy from the splendid print of Didot in the Paris edition of Virgil."

"Turn it round, vicar."

"See! see! she revives, she opens her eyes, and throws her arms around the neck of her frantic lover. Truly, Mr. Seymour, this is a most interesting toy," said Mr. Twaddleton.

Mr. Seymour here observed that he had written an epigram to accompany the subject they had just witnessed, and he trusted that he had given to it a classical *turn*.

"By all means read it; the subject admits of much classical decoration," observed the vicar.

Louise received the epigram from the hands of her father, and read as follows:

"By *turning round*, 'tis said, that Orpheus lost his wife;  
Let him *turn round* again, and she'll *return* to life."

It could not be expected that Mr. Twaddleton should have admired lines so burdened with puns; but he quietly observed, "I should have preferred a quotation from the fourth Georgic, so beautifully descriptive of the fable."

The next card that was presented for inspection exhibited the metamorphosis of Daphne into a laurel. As the figure revolved, the leaves were seen sprouting from her fingers, and her arms lengthening into branches.

"Come now," said Mr. Seymour, "let us exhibit the figure which has been designed at my request: the change which it will undergo during its revolution may, I trust, on some day be realized; I only regret that it is not in my power to give the vicar so good a *turn*."

"Really, if, like Cræmbe in Martinus Scriblerus, thou hadst a wheel for every day in the year, I should certainly say

that you were this day under the dominion of the word *turn*."

"You know this resemblance," said Mr. Seymour, as he showed the figure painted on one side of the card to his daughter.

"It is the vicar!" exclaimed Louisa.

It was, indeed, a portrait of that most excellent character, represented in the costume in which he usually appeared.

"Turn it round," said Mr. Seymour.

Louisa twirled the cord, and the effect of the rotation was to convert the humble vicar into the dignified bishop; his meager form was instantly changed into a corpulent figure, which was still further inflated by the addition of the episcopal robes and lawn sleeves, while his angular features were softened by the graceful curves of an immense wig.

"I will give you a motto for it," said the major, "and may it be prophetic!—RAPID PREFERENCE."

"I will now show you the improvement which has been effected in the construction and use of this toy," said Mr. Seymour. "It consists in altering the axis of rotation while the card is in the act of revolving, in order that the images on its opposite sides may be brought into different positions with respect to each other."

"There cannot be any doubt that such would be the effect, were it possible to change the axis in the way you propose: but how is this to be effected?" asked the vicar.

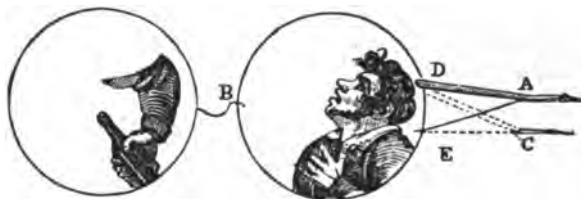
"At first I attempted to produce the change by the addition of several other strings, but I soon found, that, in order to avail myself of this expedient, I should be obliged to stop the card before I could alter the axis; whereas my great object, as I have just stated, was to produce the change while the card was in the act of spinning," answered Mr. Seymour.

"And I shrewdly suspect that such must necessarily be the case, adopt whatever expedient you may," observed the major.

"No indeed; I have at length succeeded to my entire satisfaction, and that too by a most simple scheme, after having tried without success many very complicated contrivances."

The party were very desirous of witnessing the triumph of skill, and Mr. Seymour produced the card with its appendages, of which we shall here present our readers with an engraving:

Fig. 1.



In all respects the card is constructed like the common Thaumatrope; the subject, it will be perceived, is that of a man drinking, the bottle being placed on one side, and the head on the other; upon revolving the card, in the ordinary manner, the two images will appear together as represented in

Fig. 2.



The improvement consists in inserting in one, or if a still greater change be desired, in both sides of the card, two strings, as seen in fig. 1; viz.  $A D$  and  $A E$ , which, united at  $A$ , form a common string for twirling the card. The cord  $A D$  is elastic, while the string  $A E$  is incapable of being stretched. If, therefore, while the card is in the act of spinning, the cord  $A D$  be pulled with an increased force, it will take the position  $D C$ , while the inelastic string  $A E$  will at the same time as-

sume that of  $\pi$  c. The consequence of which will be that, instead of the card spinning on the axis in the direction  $\Delta B$ , it will now spin on that which is in the direction  $o B$ , and we shall accordingly see the images on the opposite sides of the card in different positions with respect to each other; at one moment the bottle will be seen in the hand of the drinker as represented in fig. 2, and in the next at his mouth, as shown in the cut below :



while, by alternately tightening and relaxing the string, the figure will be seen in the very act of raising and lowering the bottle.

Mr. Seymour, having explained the principle of his improvement, as we have above related, proceeded to exemplify it by a series of different subjects. We shall select two or three of them for the sake of illustration. A card, with a jockey on one side and a horse on the other, on spinning round presented the combined figure; upon tightening the string, in the manner we have described, the card changed its axis, without the slightest halt or hesitation in its rotation, and the rider was in an instant canted over the head of his charger; in a moment, however, he appeared remounted; after which, by pulling the string with different degrees of force, he was made to stand on the saddle, and to exhibit a number of different movements.

The figure of an Indian juggler was represented in the act of throwing up *two* balls; on spinning the card, and at the same time altering the position of the circle, in the manner

already described, *three*, and afterward *four*, became visible. When the card revolved upon its original axis, two of the balls on the reverse side coincided with the two painted on the front, so that during the revolution they fell upon the same spot on the retina, and therefore produced a single impression; but as soon as the position of the card was changed, these spots were brought upon different points, and consequently produced separate and independent images. By alternately tightening and relaxing the strings, the balls were seen in motion, arising from and falling into the hand of the juggler.

The next subject which we shall describe produced a considerable degree of merriment. The vicar inspected the drawing, and observed that he saw a pulpit placed on the banks of a pond; the card was made to spin, when a tailor was seen haranguing from the former, and a goose, at the same instant, fluttering over the water. The circle was now suddenly shifted, and the vicar was desired to state what he saw: "Why, bless me!" exclaimed Mr. Twaddleton, "the tailor is justly served; he is ducked in the pond, while the goose has taken his place in the pulpit."

Fearing that we may have exhausted the patience of our reader, we shall only relate one more example. It was a Turk, who, by means of the expedient we are illustrating, was made to draw his saber, and cut off the head of his antagonist, which immediately fell into the hands of the decapitated person, who, like St. Denys, appeared as if walking off with perfect indifference.

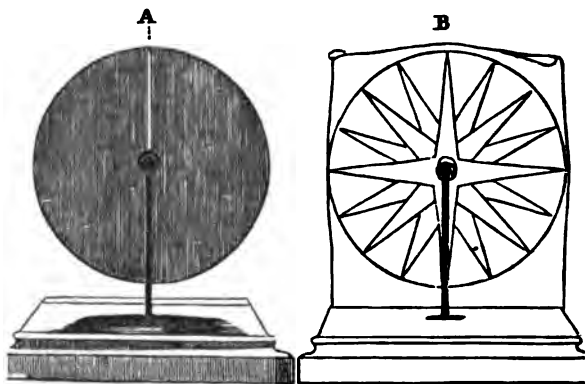
"You must admit that these effects are no less novel than they are extraordinary, and that they are capable of almost endless variation," said Mr. Seymour.

"I admit it all," replied Mr. Twaddleton, "and I have only to express a hope that, amidst all your improvements, you will never lose sight of your first and most laudable design, that of rendering your toy subservient to classical illustration: your triumph will then be complete, and I shall willingly acknowledge that there is not only philosophy but literature in your sport."



"I must not quit this subject," said Mr. Seymour, "until I have exhibited another toy, which, like the Thaumatrope, is indebted for its effect to the optical principle, which I trust is now well understood by all present, viz., that *an impression made on the retina lasts for a certain period after the object itself has been withdrawn.*"

The annexed woodcut represents the instrument to which Mr. Seymour alluded.



It consists of a disk of blackened tin plate, which is made to revolve on its axis in the manner above exhibited. A narrow opening extends from the circumference to the center as seen at A. If a device of any kind, as a star (which for increasing the beauty of the experiment ought to be transparent and illuminated with a lamp), be placed behind the disk, it is evident that, as long as the circle remains at rest, no other part of the figure can be visible than that which is immediately behind the slit A, but the instant it is put into rapid motion the whole of the star will be seen, as exhibited in figure B.

Mr. Seymour observed that the explanation of the phenomenon was obvious;—each successive portion of the figure seen

through the opening remains on the eye until the circle has completed its entire revolution.

"This experiment," continued Mr. Seymour, "admits of a very curious modification, which I shall now proceed to exhibit."

Three colored wafers were then placed, at equal distances from each other, on the disk, and, the instrument having been arranged before a looking-glass, the party were desired to observe the reflected image as the circle revolved.

"The wafers are blended into one continuous zone," observed Mrs. Seymour.

"To be sure," said Louisa; "upon the same principle that the ignited stick appears as a fiery circle."

"It would be very strange, after the different experiments we have seen, if we were not able to explain the present appearance," observed Tom.

"The fiery circle produced by the revolving stick is a much better illustration of the principle; I do not see what object Mr. Seymour has in thus multiplying his experiments," said the vicar.

"Gently, if you please, Mr. Twaddleton, and, before you favor us with your criticism, wait until I have concluded my experiment. You have seen that the reflected image of the revolving wafers appears as a continuous zone, and you have very correctly explained the reason of such an appearance; but I must now request you to inspect the reflected image through the slit in the disk, as it revolves, and say what new effect you observe."

"How very strange!" exclaimed Tom; "I see the three wafers very distinctly, and perfectly at rest."

"Impossible!" exclaimed the vicar: "let me have a peep. Why, I declare they appear, as you say, stationary, although I know them to be in rapid motion; as sure as fate I shall become a Cartesian."

The major, Louisa, and Mrs. Seymour were all equally surprised, and incapable of giving any explanation of the phenomenon they had witnessed.

"Let us remember," said Mr. Seymour, "that, in viewing the image through the slit in the revolving disk, we catch but a momentary glance as it passes before the eye, and that the image thus produced on the retina is retained until the next revolution again brings the slit into the same position. Now it is evident that, before the eye can ascertain a body to be in motion, it must observe it in two successive portions of time, in order to compare its change of place;\* but in the experiment under consideration, the glance is momentary, the wafer is no sooner seen than it passes away; its figure alone is impressed upon the retina, and this impression is continued without any change, until the circle completes its round, and consequently the image must appear at rest."

"I understand you; the figure, but not the motion, of the wafer, is discernible in the short period during which it is visible through the slit," observed the vicar.

"I lately witnessed a beautiful illustration of this subject at the Royal Institution," said Mr. Seymour. "A number of cogged wheels, cut out of pasteboard, were set in motion in a perfectly dark room, when occasional flashes of light from an electric battery displayed their forms most distinctly, and yet, although whirling round at the time, they appeared to the spectator as motionless as so many solid blocks of marble.† In like manner, in a storm during the darkness of midnight, the rolling ship and waves, when rendered visible by flashes of lightning, will appear as completely at rest as a representation of them upon the canvas. So again, in viewing a fountain in full play, the eye sees only a clouded mist issuing from the jet: but, if in the dark we cause a succession of electric sparks to follow each other at short intervals of time, we shall at once perceive that this cloud consists of distinct drops

\* "Our knowledge of motion is a deduction of reasoning, not a perception of sense; it is derived from the comparison of two positions; the idea of a change of place is the result of that comparison attained by a short process of reasoning."—*Lord Brougham*.

† Since the last edition of this work, Mr. Talbot has very ingeniously availed himself of the phenomenon for obtaining instantaneous photogenic images of bodies in rapid motion.

of water. These successive drops, when seen in one continued light, follow each other so quickly, that the eye receives new impressions before the previous ones are extinguished, and hence a mass of confusion: whereas, in the instantaneous light which is shed by electricity, each impression stamps its image before the succeeding one can interfere with it, and a pause is afforded for the exercise of distinct sensation. I may at some future time extend this interesting subject by exhibiting some optical illusions produced by the revolution of wheels in different directions and at different velocities, for the knowledge of which we are indebted to Mr. Faraday;\* and, in mentioning that distinguished philosopher," added Mr. Seymour, addressing himself more particularly to the vicar, "I cannot avoid remarking, that, if *Philosophy in Sport* can be made *Science in Earnest*, the juvenile lectures delivered by that professor have established the converse proposition, that the sternness of Science may be relaxed into the engaging aspect of Sport."

"Before quitting this subject," continued he, "I have yet another toy in store for your amusement; it is founded upon the optical principle which I have every reason to believe you now thoroughly understand." A square box was then produced containing a number of card disks, the edges of which exhibited a series of notches corresponding with the figures delineated on their margins. That the reader may better understand their construction, as well as the explanation of Mr. Seymour, the following representation has been introduced.

"To exhibit the magical effects of this toy," said Mr. Seymour, "I will, by means of the spindle to which it is attached, cause it to revolve rapidly before the looking-glass, and you shall view the reflection through the openings."

Each member of the party obeyed in succession the direction thus given, and severally expressed the great astonishment they felt, at observing the figures in constant motion, and exhibiting the most grotesque attitudes.

\* See Journal of the Royal Institution, No. 2.

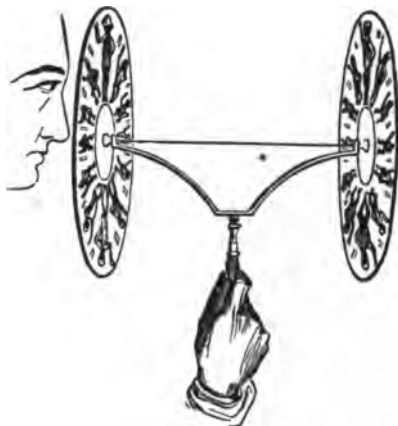


"Now," said Mr. Seymour, "attend to my explanation. Each figure is seen through the aperture, and as it passes and is succeeded in rapid succession by another and another, differing from the former only in attitude, the eye is cheated into the belief of its being the same object successively changing the position of its body. Consider what takes place in an image on the retina when we actually witness a man in motion; for instance, a man jumping over a gate: in the first moment he appears on the ground, in the next his legs are a few inches above it, in the third they are nearly on a level with the rail, in the fourth he is above it, and then in the successive moments he is seen descending as he had previously risen. A precisely similar effect is produced on the retina by the successive substitution of figures in corresponding attitudes, as seen through the orifices of the revolving disk; each figure remaining on the retina long enough to allow

its successor to take its place without an interval that would destroy the illusion."

"Nothing can be more satisfactory than your explanation of this very extraordinary toy," observed the vicar.

"I am now about to exhibit what I consider a great improvement in its construction, inasmuch as we thus get rid of the mirror, and enable two persons to witness the deception at the same time," said Mr. Seymour. "For this purpose I have a spindle, at each end of which a disk is placed, and which I hold in my hand." We deem it expedient to illustrate this arrangement by a woodcut.



"By revolving the spindle, you perceive that both cards are made to turn round with equal velocity. Tom," said his father, "look through the orifices of the disk on my right hand, and, Louisa, do the same on my left." The children obeyed, and simultaneously expressed their wonder at what they witnessed. "The figures are all dancing!" cried Tom. "The horses are all prancing!" exclaimed Louisa.

"You have not yet told us the name of this toy," observed the vicar.

"It has received several names," answered Mr. Seymour, "as *Phantasmoscope*, *Phanastiscope*, &c., derived, as you no doubt perceive, from the Greek." It is scarcely necessary to observe that the appearances thus produced may be infinitely varied: heads opening their mouths, and distorting their countenances; creeping serpents, and machinery in active operation, are among the subjects that have excited the greatest admiration.

Louisa here observed, that she had lately seen a most extraordinary optical illusion, termed "*Fluttering Hearts*."

"You allude to the figures, worked in worsted, on a ground of a complementary color," said her father.

"To be sure; and by moving about the tablet before the subdued light of a lamp or candle, the figures in question will appear as if in motion, and quite free, and disconnected with the ground upon which they are depicted," answered Louisa.

"I am glad you have directed your attention to an appearance which has much puzzled wiser heads than our own," observed Mr. Seymour.

"I also have heard that some difference of opinion exists as to the exact cause of this illusion," said Miss Villers, "and have prepared a specimen for your use, not worked in worsted, but painted on card; and I have, moreover, given to it the convenient form of a hand-screen, which I now place at your disposal."

"Many thanks, my dear Miss Villers."

Mr. Seymour, in the evening of the day, drew his family party around him, and by the aid of a candle was enabled to exhibit the extraordinary appearance above related.

"Now," said he, "in order to arrive at some satisfactory explanation of this appearance, let us slowly and carefully observe what takes place. If we fix the eye upon some salient point of the figure, we shall soon become convinced that it does not actually change its place, with reference to the colored ground upon which it is depicted; and if, next, we notice what change takes place on the surface of the figure, as the tablet is moved to and fro, we shall detect a

'*penumbra*,' that is, an imperfectly defined shadow, flitting across it. Now if this fact be admitted, two distinct questions will arise out of it: first, how is the shadow produced? and secondly, upon what principle is the idea of motion thus conveyed by it?—In answer to the first of these questions, I must express my belief that it is a lingering impression upon the retina, produced by that of the colored ground, or that the color of the figure, and that of the ground, unequally retain their hold upon the eye, as to duration of time, and consequently that one impression, if I may so express it, overlaps the other."

"After your explanation of the retention of an image for several seconds by the eye, I think I can comprehend your meaning," said Miss Villers.

"Well, if this be granted, I think I can convince you, by ocular demonstration, that the transit of a shadow over an illuminated surface will have a tendency to produce apparent motion." So saying, Mr. Seymour proceeded, with lamp in hand, to the marble bust of Newton, that was mounted on a pedestal in a corner of his library, and on slowly moving the light, in different directions, before it, the whole party acknowledged that the countenance certainly became apparently animated by varied and changing expressions.

The party now dispersed, not less gratified than they had been instructed by the lesson they had received.

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